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ABSTRACT

Volume II of a three-volume study on the future of the food service industry considers the effects that centralized food production will have on the future of food production systems. Based on information from the Fair Acres Project and the Michigan State University Vegetable Processing Center, the authors describe the operations of a centralized production facility and discuss the equipment needed for such operations. The other points considered by this study are microbiological quality control for centralized food preparation facilities; problems with regulations in the food processing and delivery industries; the distribution-transportation problem of commissary operations; and the potential commissary function for the wholesaler. (BM)

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FINAL REPORT

CENTRALIZED FOOD SERVICE SYSTEMS

Forecasting the Future Food Service World of Work

Volume II

(Project No. 19-4009)

edited by

Thomas F. Powers, Ph.D.

Professor in Charge

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Introduction and Acknowledgments

This volume recognizes the importance of the centralized food production facility and the impact it is bound to have in the next ten to fifteen years on food production systems. It considers not only the operational issues of how centralized food production facilities might function and with what sorts of equipment, but also the regulatory problems of centralized food service systems and the problems in the area of microbiological control which these systems suggest. Moreover, in Dr. Mann's work, the issues of physical distribution receive careful attention.

While some of the authors of this volume were formally involved in the original funded project, a number of others were drawn to work with us by their interest in the subject matter itself and by the ad hoc needs of the Food Service and Housing Administration faculty for their expertise. In particular, I would like to acknowledge my indebtedness to Dr. Stuart Mann, Associate Professor of Operations Research and Chairman of the Operations Research Committee, College of Human Development, The Pennsylvania State University, for developing, with Ms. Cecelia Miles, the unusually useful section on transportation strategies and the means of planning them. Professor Mann has also provided a useful bibliographic reference to the major work done in the area of operations research in the food service industry.

Ted L. Smith, Publications Officer of the National Association of College and University Food Services based at Michigan State University, was generous with his time in developing the section on centralized vegetable preparation. He also provided the photographic materials to help

make this relatively new area more comprehensible. His helpfulness has resulted in another useful addition to this volume.

And finally, I thank my wife, Jo Marie Powers, not only for her authorship of the section on microbiological issues in centralized food service, but also for the many contributions she made in shaping my thinking in the whole area of centralized food service systems.

The following acknowledgments recognize those who contributed their efforts to all three volumes of this comprehensive project collectively entitled "Forecasting the Future of the Food Service World of Work." John Swinton, who provided editorial assistance for the first year's report, played a similar role in Volumes II and III of this year's work as well. He oversaw the production of all three volumes of the present work. All of the participants are indebted to him: John often helped us understand more clearly what we were trying to say as he supplied the editor's hand to the substantive work undertaken.

I would like to note, too, the indebtedness of those of us on the Food Service and Housing Administration faculty involved in this project to our colleagues who were not involved and yet gave willingly of their professional expertise in shaping our ideas--all the time bearing their regular share of the classroom and research work.

Finally, this report owes a great debt to the Williams family of Pleasant Gap, Pennsylvania. Ms. Rhoda Williams was responsible for the administration of the clerical staff who prepared early drafts as well as the final report. As it happens, that clerical staff included her sister, Bonnie Williams, and her sister-in-law, Vera Williams. Mrs.Cindy Brown also provided clerical assistance. And Mrs. Ruth Kilhofer and Mrs. Anna Mortimer typed the mats from which this volume was produced--

an exacting task which they carried out with speed, diligence, and patience.

Those of us who have participated in this project feel that we have laid the groundwork for important work at all levels of Hospitality Education. Once again, The Pennsylvania Department of Education has demonstrated, almost uniquely among funding agencies, an awareness of the need to provide substance before providing form in Hospitality Education. The Research Coordinating Unit of that department has been an exacting taskmaster, but that role has been most productive for those of us who worked on this project. The effects of the work done here will certainly be felt in the immediate future of Hospitality Education and will also be felt there for many years to come.

June 30, 1975 Thomas F. Powers

University Park, Pennsylvania

TABLE OF CONTENTS

Introduction and Acknowledgements iii

I LARGE QUANTITY FOOD PRODUCTION SYSTEMS
Thomas F. Powers, Ph.D. and Betty Jayne Williamson, R.D. 1

Introduction 3

The Fair Acres Project 13

Menu Planning 13

The Steamatic Unit (Steam Cooker) 23

The Hydro-Thermic (Water Cooker) 24

The Auto-Fryer Unit (Deep Fat Fryer) 25

The Pyro-Grill (Grill) 25

The Auto-Broil Unit (Broiler) 27

Packaging and Freezing 27

System Operation: Distribution 30

Conclusion 35

References 37

II THE MICHIGAN STATE UNIVERSITY VEGETABLE PROCESSING CENTER
Ted L. Smith and Donald H. Ralph 39

Introduction 41

A Description of the Operation 42

Facilities and Equipment 43

A Discussion of Preparation Processes 49

Trimming 51

Washing 52

Coring 53

Hand-cleaning 53

Cutting 53

Antioxidant Treating 54

Dewatering 54

Advantages of the Michigan State Vegetable Center 54

Lettuce Processing 54

Onion Peeling 55

Salad Dressings 57

Mixed Salads 58

Gelatin Salads 58

Control Factor 60

Conclusion 60

III MICROBIOLOGICAL QUALITY CONTROL FOR CENTRALIZED FOOD PREPARATION FACILITIES
J. M. Powers, B.S. 63

Introduction 65

Microbiological Tests Used in Food Production Systems 66

Standard Plate Count 67

Coliform Count 68

Interpretation of Microbiological Tests 69

Setting Limits 73

Reasons for Microbiological Quality Control Programs 76

Safe Foods 76

Increase Sales and Profit by Increasing Shelf Life 78

Conforming with Sanitary Regulations 84

Overview of a Microbiological Quality Control Program for Centralized Food Service 87

Areas for Microbiological Control in Centralized Preparation 92

Raw Ingredients 92

Processing 92

Storage 93

Transportation 93

The Retail Outlet 94

Overall Control 95

Summary 95

References 98

Appendix A, Numbers of Bacteria in Food 103

Appendix B, Samples of Microbiological Specifications 105

Appendix C, "Certain Bacteria in Food Require Total Attention" by Kurosh Ostovar, Ph.D. 109

Appendix D, "Recommendations for Prevention of Bacterial Food Poisoning" by Garden State Laboratories, Inc., Irvington, N.J. 115

IV PROBLEMS WITH REGULATIONS IN THE FOOD PROCESSING AND DELIVERY INDUSTRIES - PENNSYLVANIA: A CASE STUDY
Manfred Kroger, Ph.D. 119

Introduction 121

Eating Establishments 124

Food Processors 127

Conclusion 130

Appendix, A Summary of Laws Administered by the Pennsylvania Department of Agriculture, Bureau of Foods and Chemistry 131

V THE DISTRIBUTION-TRANSPORTATION PROBLEM OF COMMISSARY OPERATIONS
Stuart H. Mann, Ph.D., and Cecelia M. Miles, M.S. 141

Introduction 143

The Commissary Problem 144

A Mathematical Approach 146

The Hallberg Program for Vehicle Routing 151

Application of the Hallberg Program to Commissary Distribution 155

Implications for the Food Service Industry 167

References 171

Appendix A, List of Items Distributed From the Commissary 174

Appendix B, Route 1 - An Algorithmic Approach to Commissary Distribution 176

Appendix C, Route 1 - An Algorithmic Approach to Commissary Distribution 185

VI THE POTENTIAL COMMISSARY FUNCTION FOR THE WHOLESALER or "How It All Might Work For The Independent"
Thomas F. Powers, Ph.D. 191

CONTRIBUTORS TO THIS VOLUME 199

A List of Figures and Tables

I LARGE QUANTITY FOOD PRODUCTION SYSTEMS

Figure 1:	Twenty-eight Day Food Production Requirements	4
Figure 2:	Fair Acres Center Layout	6
Table 1:	Ratio of Productive Man Hours to Total Man Hours	7
Figure 3:	A Cooking Street Viewed from the Finished Product End	8
Table 2:	Man Hour Use in Restaurants by Function	8
Figure 4:	The Steamatic (Steam Cooker)	10
Figure 4a:	Containers on Motor Driven Chain	10
Figure 5:	Hydro-Thermic (Water Cooker)	12
Figure 5a:	Interior View of Hydro-Thermic	12
Figure 6:	Pyro-Grill (Flipper)	14
Figure 6a:	Cooking Surface of Pyro-Grill	14
Table 3:	Cart and Patient Count for Fairacres Food Production and Distribution Center	15
Figure 7:	Auto-Broiler	16
Figure 7a:	Auto-Broiler - A Working View	16
Figure 7b:	Cutlets Being Hand-Fed into Auto-Broiler	17
Figure 7c:	Cutlets Being Unloaded from Auto-Broiler	17
Table 4:	Comparison of Staffing Requirements	19
Figure 8:	Cooking Street - The Loading End	20
Figure 8a:	Cooking Street in Operation	20
Figure 9:	Co-fill System	22
Figure 9a:	Co-fill System Showing Rear of Portioning Unit and Transferring Unit	22
Figure 9b:	Co-fill System Showing Unloading End of Automat	24

Figure 10: BBC-Contair-Froster Typ IV 26

Figure 11: Food Being Portioned into Individual Containers 28

Figure 11a: Food Entering Packaging Unit 28

Figure 11b: Food Being Removed from Holding Freezer on Floor 29

Figure 11c: Food Being Placed in Convection Oven 29

Figure 12: Tray Assembly and Module Distribution Schedule 32

Figure 13: Food Production and Distribution System Operation 34

II THE MICHIGAN STATE UNIVERSITY VEGETABLE PROCESSING CENTER

Figure 1: The Urschel Cutter 45

Figure 2: Two Views of the Bagging Operation 47

Figure 3: The Trimming Operation 49

Figure 4: V-type Vegetable Washer 50

Table 1: Vegetable Preparation Processes 52

Figure 5: Schematic Drawing of the Lettuce Processing Operation 56

Figure 6: The Onion Hood 57

Figure 7: Schematic Drawing of the Salad Dressing Operation 59

Table 2: Vegetable Processing Center Weekly Production Averages 61

III MICROBIOLOGICAL QUALITY CONTROL FOR CENTRALIZED FOOD PREPARATION FACILITIES

Table 1: Farm Suppliers of Raw Milk 70

Table 2: Holding Quality Test with Job Responsibility 72

Table 3: Distribution of Total Counts 75

Table 4: Places Where Foods Were Mishandled in Such a Way that Food-borne Disease Outbreaks Resulted 77

Figure 1: Shelf Life of Chicken Meat 81

Table 5: Total Counts of Commercially Packed Spices 83

Table 6: Pennsylvania Plant - Holding Quality Test (Homogenized Milk) 89

Figure 2: Meat Process Control Chart 96

Figure C-1: Foodborne Disease Outbreaks, Confirmed and Unconfirmed, in the United States, 1971 113

V THE DISTRIBUTION-TRANSPORTATION PROBLEM OF COMMISSARY OPERATIONS

Figure 1: Location of Delivery Points on Grid 156

Table 1: Percentages of Total Weekly Deliveries that are Frozen Items 158

Table 2: Unit Demand of Frozen Food Items for Four-Week Period 160

Table 3: Demand at Each Stop in Average Total Weight and Average Total Volume 161

Table 4: Vehicle Data Summary 163

Table 5: Summary of Proposed Schedule of Routes 165

Table 6: Comparison of Weekly Delivery Costs: Present vs. Proposed 166

LARGE QUANTITY FOOD PRODUCTION SYSTEMS

by

Thomas F. Powers, Ph.D.

and

Betty Jayne Williamson, R.D.

LARGE QUANTITY FOOD PRODUCTION SYSTEMS

Introduction

Traditional food service systems, whether they be full-service restaurants, hospitals, or dormitories, are based on a resource cost pattern characterized by relatively inexpensive labor and an adequate supply of skilled labor. Since the end of World War II, this resource pattern has clearly changed. First of all, the chef-apprentice training system, which was the basic source of skilled food service labor in pre-World War II times, broke down, in part, as a result of the reduction in the number of immigrants allowed to enter this country from Europe. More fundamentally, however, the chef-apprentice training system and informal adaptations of that system in this country broke down under the impact of the thirty years of economic growth that followed World War II, which offered many more attractive alternate employment opportunities to people who might have been drawn into the traditional training system. The chef-apprentice system was characterized by very low or no wages for a three-year apprenticeship period followed by relatively low wages for a number of years until a fairly senior position was achieved. Alternate opportunities available in other industries with relatively high income commonly led workers to choose other options. By 1972, the average weekly earnings for non-supervisory workers in eating and drinking places was about $57 a week while the average weekly earnings of non-supervisory production employees in the economy in general was nearly $120 a week. Unfortunately, historic data on average wage for restaurant employees does not extend back far enough to make a meaningful comparison on immediately post-war wage patterns (5).

Assumed Census: Breakfast 4000, Lunch 6000, Dinner 5600

Figure 1

TWENTY-EIGHT DAY FOOD PRODUCTION REQUIREMENTS
(SAMPLE)

ITEM	DESCRIPTION	COOKING TIME	SERVING SIZE	CYCLE FREQUENCY	TOTAL CYCLE REQ.	EQUIPMENT REQUIREMENTS	TOTAL PROD.HRS
Hot Cereal	Thin-Thick Light-Dark	20 min., (60) gal. load, cook, unload	8 oz.	28	7000 gal.	Round tilting kettle w/agitator	58
Scrambled Eggs	Frozen whole eggs	30 minutes (60) gallon	3 oz. (2 eggs)	12	1120 gal.	Round tilting kettle w/agitator	14
Bacon, 1#= 1#=18 slices 9"Lx5"W	Fresh or frozen 1# cut slab	3 minutes 3240 SL/HR	2 slices	4	32,000 SL 900#	Continuous grill	10
Pancakes	Mix	3 minutes 2000 pancakes/hr.	3 ea.	4	48,000 pancakes	Continuous grill	24
Roast Beef	Rounds 15-18# Roasts	15/20 min/# 300°F	4 oz.	2	3734# raw 2800# yield	8 shelves Convection Oven	40
Meat Loaf	Fresh ground meat meat loaf mix seasonings	50 minutes	3 oz.	2	12000 servings 3000# raw 2250 yield	16 shelves Convection Oven	10
Veal Cutlet	Fresh	6 minutes 1500 PC/HR	3 oz.	2	11200 servings 2800# raw 2100# yield	Continuous broiler or Continuous grill	8
Macaroni & Cheese	Macaroni Cheese sauce Brown-off	15 minutes 1 hour 1/2 hour	6 oz.	2	9200 servings 2300#, 144 gal. (1152#)	Hydro-Thermic Automat 53 gal. blockkettle Convection Oven	4 4 6
Potatoes	Dehydrated frozen, fresh peeled, diced, whole cubed fresh (baking)	As required	4 oz.	18	Varies according to type for lunch or dinner	Hydro-Thermic Automat Steamatic Automat Convection Oven Continuous grill	10 12 40
Casserole Dishes	Various	15-25 minutes	6-8 oz.	20	Varies according type for lunch or dinner	Steamatic Automat	30
Vegetables	All types Fresh/Frozen	Fresh: 20-25 min. Frozen: 15 min.	4 oz.	28 28	42,000# lunch 32,200# dinner	Steamatic	80 30
Desserts Pies, Cakes Cookies	Raw ingredients Mixes	20-60 minutes Based on item	2-4 oz.	42	46 varieties	Convection Oven	122

Not only have food service workers become relatively hard to find, but they have also become relatively more expensive to employ. Some of the initial forces driving up wages, aside from competitive wage levels in the economy in general, have been the minimum wage and unionization or the threat of unionization. For the past ten or fifteen years, however, income for "non-work activities" has increasingly become competitive with wages for work in food service establishments. Thus, in 1972, the average AFDC benefit per family (including a $30 income disregard factor) was about $220 per month, while the average earnings in food service employment in the same period was about $230. The average unemployment benefit in the economy was actually greater in 1972 than the average monthly earnings of food service workers (5). Clearly developments in "non-work" income patterns constitute a floor under unskilled wages that is increasingly significant. At the same time, welfare and unemployment compensation have actually become competitors with the food service industry in many places for the same person as an employee or as a client.

Some writers have seen the basic challenge to the food service industry in overcoming rising costs as that of increasing productivity within the existing system. Freshwater and others have shown that there is a substantial amount of waste time in all food service systems when they are viewed from an industrial engineering perspective (2, 3, 4) (Table 1 depicts the level of worker productivity found by Freshwater.) While this point of view clearly has merit, the question arises as to how much of the 20 to 30 percent of "non-productive manhours" Freshwater identifies can be attributed to the basic inefficiency of a productive system contingent on the arrival and ordering behavior of the guest and

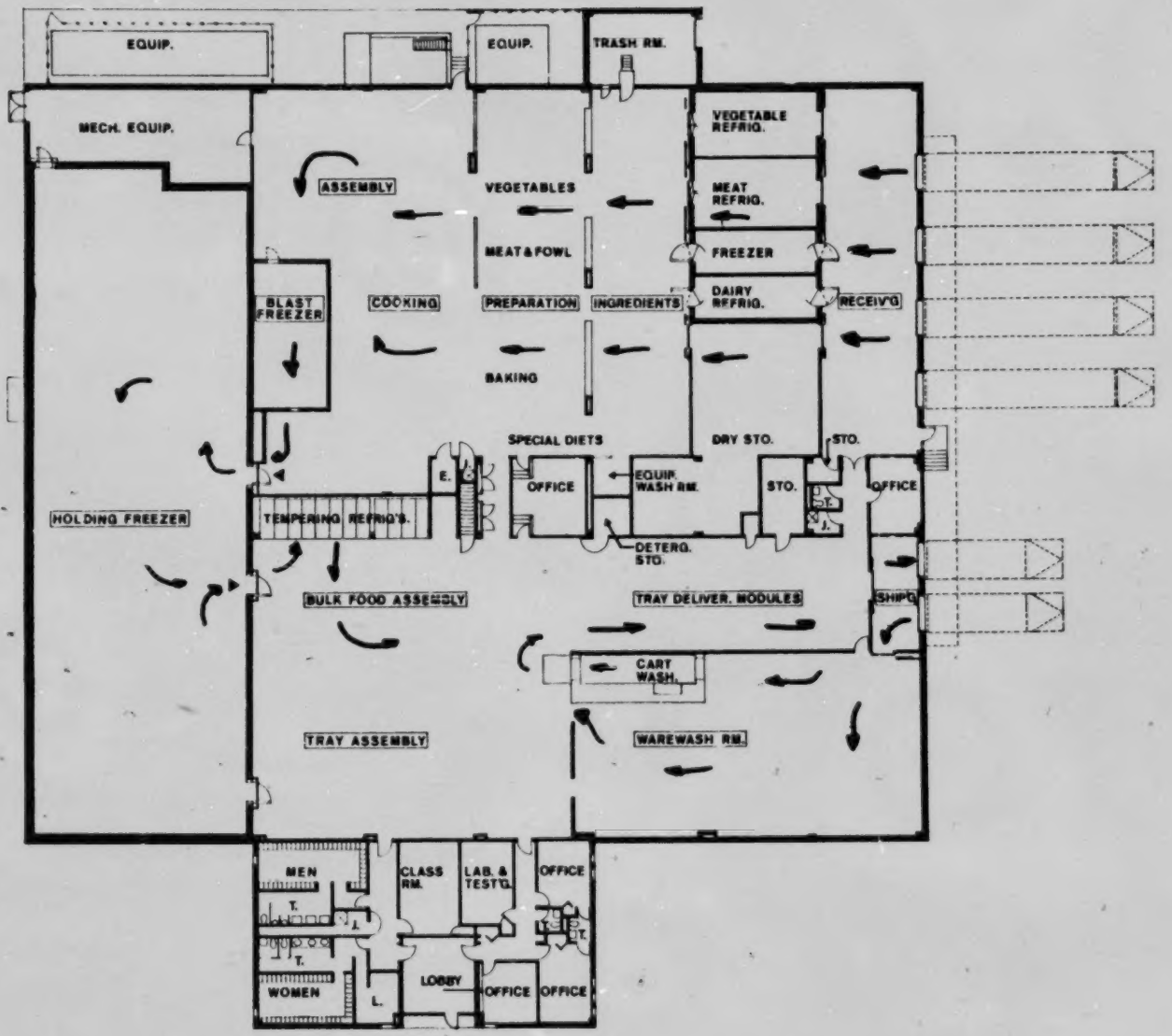


Figure 2
Fair Acres Center Layout

how much remains the result of a lack of employee motivation or poor planning on the part of management.

Another basic problem of the traditional restaurant is that a substantial commitment of man hours is made to relatively inefficient small scale production. As Table 2 indicates, between 25 and 35 percent of the typical restaurant or cafeteria man-hours budget is spent on food production with an additional 16 to 18 percent being concentrated on warewashing.

Table 1

Ratio of Productive Man Hours to Total Man Hours[c]

	Performance
Single Line Cafeterias[a]	81.2
Double Line Cafeterias[a]	70.0
Family Type Restaurants[a]	77.9
Occasion Type Restaurants[b]	73.9

[a]Average of Six Studied
[b]Average of Seven Studied
[c]Based on Work Sampling

Source: Agricultural Research Service

Recent information on changes in the composition of the American restaurant industry supports the notion that the traditional restaurant is often an inefficient unit and suffers the expected effect of inefficiency in a competitive industry. Between 1960 and 1971, the total number of restaurants in the United States increased by 9,000. But since the number of fast food establishments increased by approximately 30,000 during this period, it appears that, in a period of considerable economic growth, there was a reduction of approximately 21,000 restaurants of the traditional format--a decrease of nearly 10 percent. In the same period

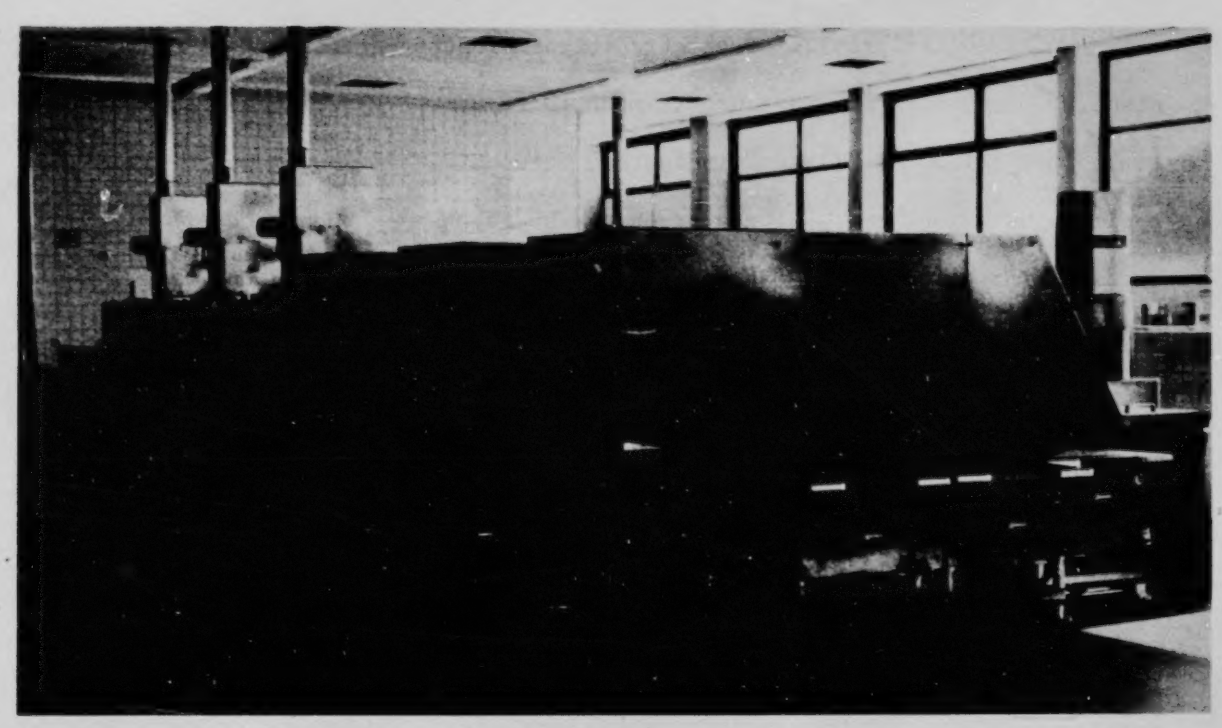


Table 2. Man Hour Use in Restaurants by Function

	Single Line Cafeteria[a]		Double Line Cafeteria[a]		Family Type Restaurant[a]		Luxury Restaurant[b,c]	
	Hours	%	Hours	%	Hours	%	Hours	%
Food Production	6.35	34	4.88	27	5.29	25	19.12	29
Ware Washing	3.10	17	2.86	16	3.47	17	11.75	18
Customer Service*	8.94	49	10.61	58	12.10	58	35.75	53
	18.39	100	18.35	100	20.86	100	66.62	100

[a]Average of Six Studied
[b]Average of Seven Studied
[c]Excludes bartending

Source: Agricultural Research Service

fast food units increased from 6.6 to 18 percent of the total restaurants in operation in the United States (6). The industry's adaptation to the changing cost and labor supply sketched above appears to be, in large part an alteration in the kind of food service system in use as indicated by what kind of system is prospering in the market place. Fast food establishments, with a much simpler production system (as well as an almost complete elimination of service) are able to deliver a very narrow product line to guests at an attractive cost.

Another kind of systemic change that appears to be taking place is that of separating the food production operation from the restaurant. Califano and Weis offer four basic reasons for the adoption of frozen-prepared foods to reduce kitchen payroll and simplify operations. First of all, factory preparation eliminates "the built-in inefficiency of the restaurant" in which production is contingent on the arrival and ordering behavior of the guest. Second, factory preparation also offers significant economies of scale over even the largest commercial restaurants. Third, the factory can also make more efficient use of such joint products as the various cuts of meat on a carcass, trimmings, bones, etc. Finally, the space cost of a factory is less, particularly those associated with land cost in typical manufacturing locations as contrasted with land and space costs in a good food service location (1).

The frozen-prepared food strategy, however, has presented a number of difficulties. Basically, operators have found that the quality of frozen foods available is often not acceptable to the better class of restaurant and the variety of quality products available has been entirely too limited. Moreover, the cost of frozen-prepared products is often higher than the cost of preparing the food on premises--even after

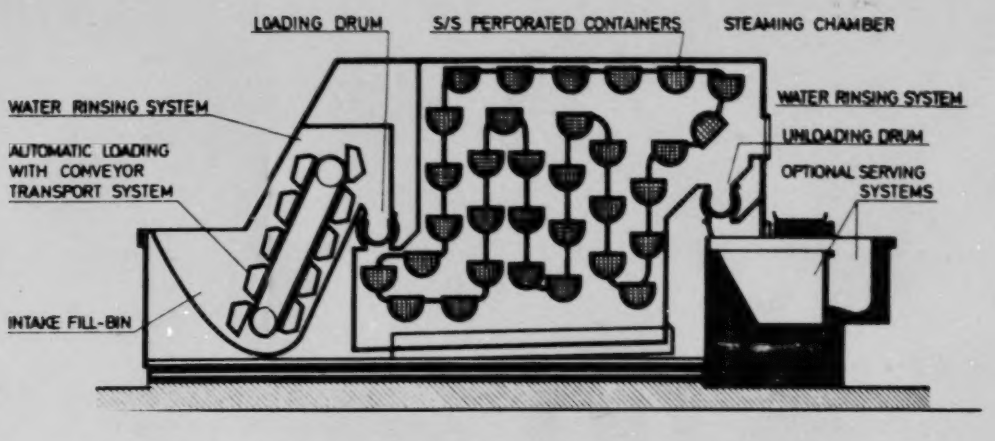


Figure 4
The Steamatic (Steam Cooker)
This unit is bulk loaded, initially, and it then automatically portions and transports the food to be cooked through the unit, and automatically unloads. This is the key to all of the automats; continuous, high volume production in small batches.

Figure 4a
Containers on Motor Driven Chain
These perforated stainless steel containers are removable from the unit for cleaning, as desired. The access door is also convenient for washing the interior of the unit, even though it is self-cleaning.

considering variable labor cost. In general, the scale of production required for a frozen food plant or similar operation is such that a limited number of relatively standard products developed for national market are the best that can be hoped for. This standard, often undistinguished product then requires expensive refrigerated transportation. Thus, while the use of frozen prepared food is unquestionably on the rise, its universal acceptance, widely predicted as early as fifteen years ago, has not yet taken place.

Another strategy for separating the food production component from the restaurant system has been the adoption of commissaries or other centralized preparation facilities. In this kind of system the vast majority of the "kitchen" is removed to a centralized food production facility which may be thought of as a commissary (intra-state) or as a factory (inter-state). The difference is a legal and regulatory distinction. Legal distinctions aside, the term we will use to describe the facility being considered here is "Food Production and Distribution Center."

Just as commercial restaurant chains have moved toward centralizing their production either in their own facility or through purchasing frozen products prepared by others, so also have institutions such as hospitals and dormitories and other large domicilary institutions begun to move toward a centralized production strategy. The institutional (as opposed to a restaurant) setting is basically a more efficient one in that the production system can operate on the basis of a fairly predictable demand for any given period. Nevertheless, a systemic view--from a food production standpoint--of a number of institutions which are under the same authority, suggests that it is no longer appropriate in the light of cost constraints to maintain their food services separately. The balance of

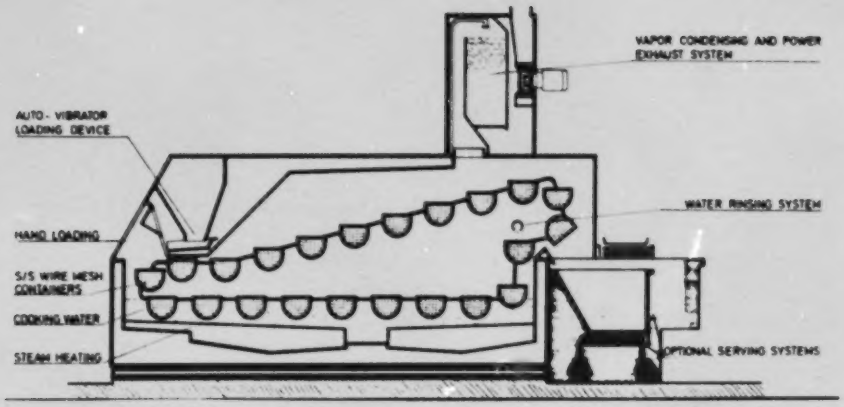


Figure 5
Hydro-Thermic (Water Cooker)

The Hydro-Thermic operates in a fashion similar to the Steamatic. The unit is used for cooking products such as pasta, dehydrated potatoes, rice, etc.

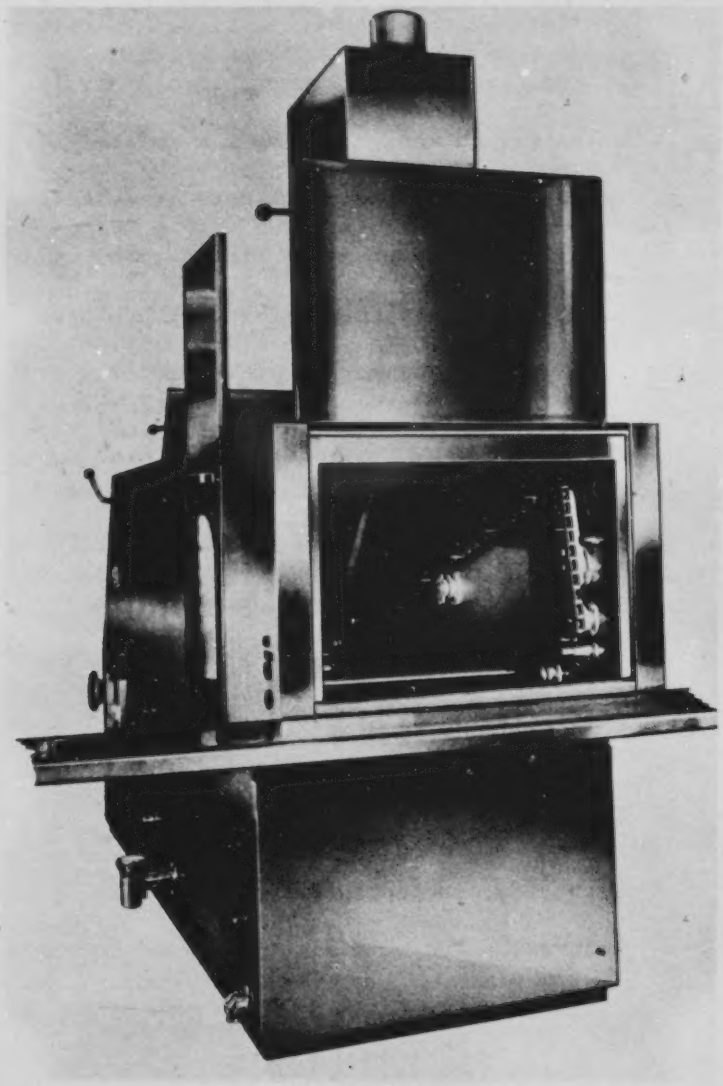


Figure 5a
Interior View of Hydro-Thermic
This picture show the unloading end and the chain drive system, with the access door open.

this paper will discuss one particular food production system that uses equipment manufactured by Neff-Werke GMBH, basically drawing on the Delaware County Institutional District Installation (called the Fair Acres Project) under construction outside Philadelphia, as an illustrative case. While this example is institutional, it is clear that the centralized food production facility could readily be adapted to the needs of other kinds of food service operations.

The Fair Acres Project

The Project takes its name from Fair Acres Farm, a geriatric center consisting of six buildings. The Fair Acres Food Production and Distribution Center (hereafter, "Center") will serve a much wider population, however, including two county prisons (a men's and a women's facility) a juvenile detention center, an orphanage (children's cottages), a day care center, and a congregate feeding program for the elderly. The population of the various units is summarized in Table 3.

Menu Planning

As is generally the case with food service planning, the document dictating the plan of the Fair Acres facility is the menu. A four-week or 28-day menu cycle was established as the initial base for planning.

The 28-day menu cycle was drafted on the basis of meeting demands across age groups (varying from very small children in the day care center to the very elderly at Fair Acres Farm), the food preferences of the clientele, and the budget available. The strategy inherent in this particular food factory system is that of periodic high volume production runs in which all of a single food item required for the 28-day cycle menu

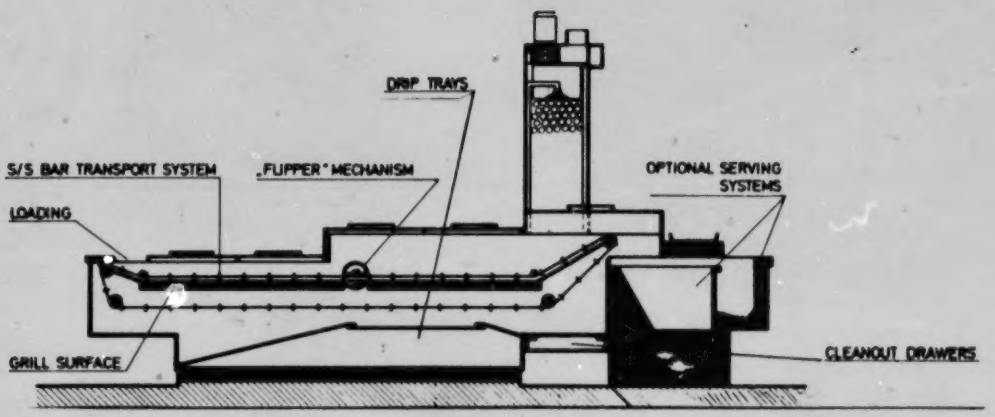


Figure 6
Pyro-Grill (flipper)

This equipment is normally furnished with removable stainless steel covers over the cooking area, and has its own built-in exhaust and ventilation system. The Flipper can process items that normally would be grilled, such as hamburgers, hot dogs, french toast, grilled cheese sandwiches, pancakes, bacon, liver, etc., and, in addition, can also be used as a shallow fryer by adding a fat depth of about 2" onto the grill surface, and then the transportation bars will fry items like flat fish, chicken, french fries, etc.

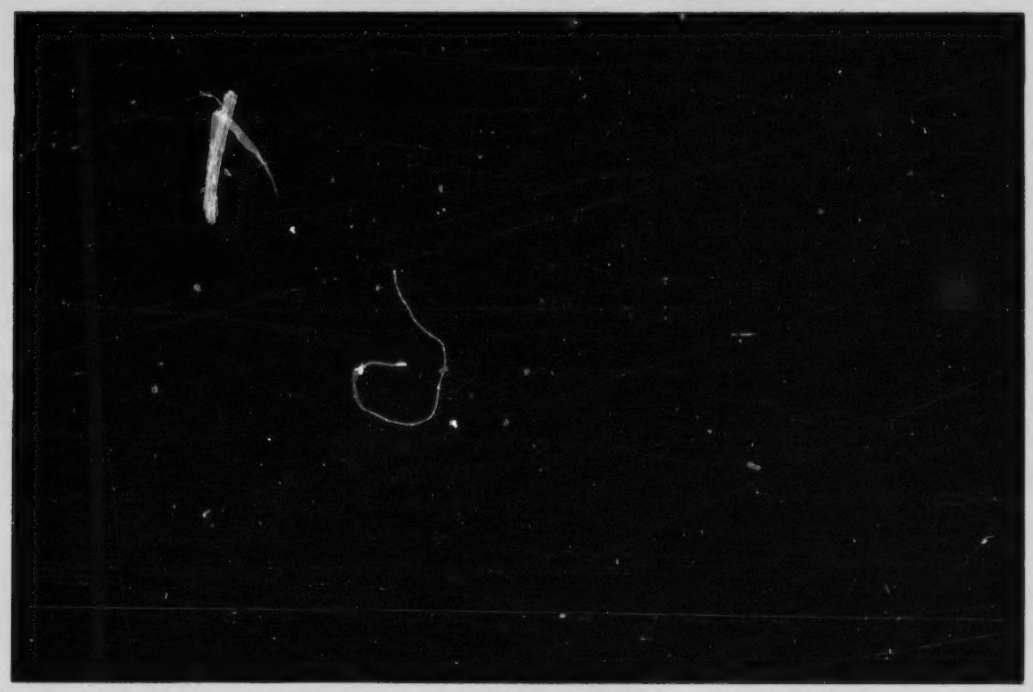


Figure 6a
Cooking Surface of Pyro-Grill

This illustration shows the unit with the covers removed and the transportation bars which are removable without tools from the chain drive for cleaning. The speed at which the product moves through the cooking zone is adjustable, as is the case with all automats, and in the case of the Flipper, the turning mechanism can be disengaged so that a product, if desired, can pass over the entire length of the unit without turning.

is produced in a continuous process. Once the 28-day menu cycle was drafted, the following criteria were established to determine the food demands for each product from each of the distribution centers: a portion size of each food item, the number of times each food item is repeated on the cycle, and the anticipated census requirements.

Table 3. Cart and Patient Count for Fairacres Food Production and Distribution Center

Fairacres	
Residents	1350
Staff	1140
Fairacres Children's Cottages	
Children	50
Staff	25
Juvenile Detention Home	
Children	25
Staff	35
Men's Prison	
Inmates	300 to 500
Staff	175
Women's Prison	
Inmates	40
Staff	10
Day Care Center	
Children	100
Staff	20

In traditional kitchen design, the object is to plan a kitchen that can produce all the items on a menu within the time frame imposed by daily meal scheduling. Clearly, the food factory problem is quite different. The basic design parameter of the Fair Acres Food Factory is the

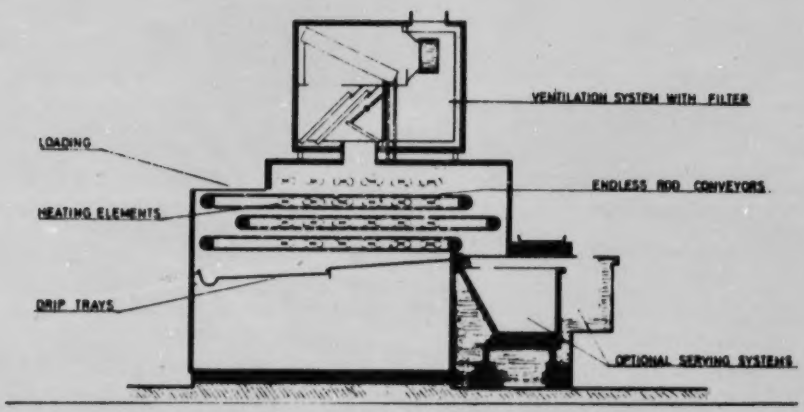


Figure 7
Auto-Broiler

This unit will accommodate, in high production volume, any item that would normally be broiled. The transportation time is adjustable and the heating is a combination of radiation and convection, with the heating elements always on so that every product has the same cooking exposure and history. The convected heat is controlled by the automatic ventilation and filter system which senses the need for the exhaust fan to speed up or slow down, depending on the internal heat of the unit.

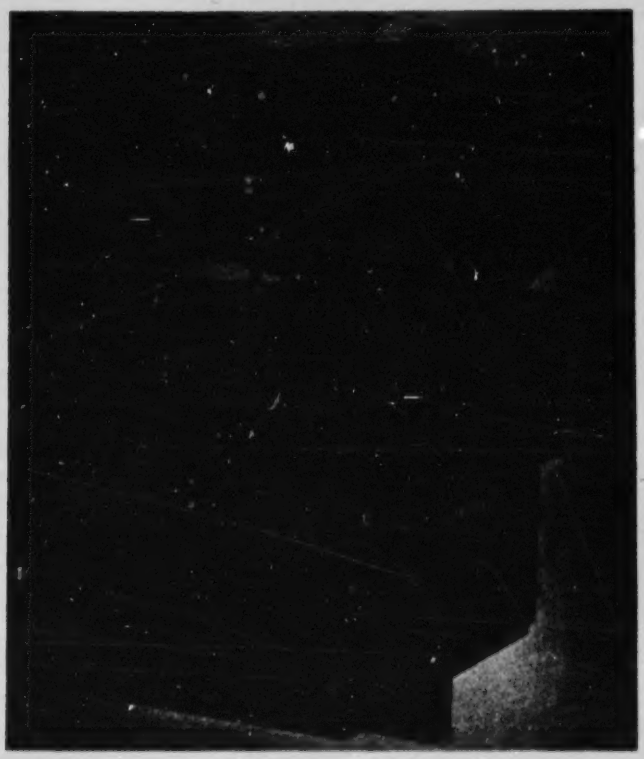


Figure 7a
Auto-Broiler - A Working View

This photo shows the loading end, with the food product transport system conveyors partially removed. At the end of the production day, these conveyors are withdrawn from the unit and submerged in a portable tank with detergent and hot water, controlled by a heating element that softens the baked on food residue so that the following morning the conveyors can be brushed down, washed, rinsed off and reinserted into the Auto-Broiler.

Figure 7b
Cutlets being hand fed into the Auto-Broiler

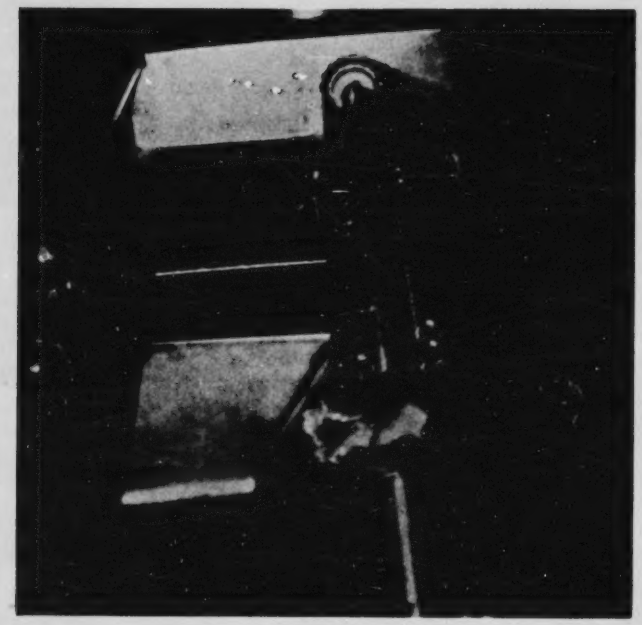


Figure 7c
Cutlets being unloaded from the Auto-Broiler into a bulk container stationed beneath the discharge opening.

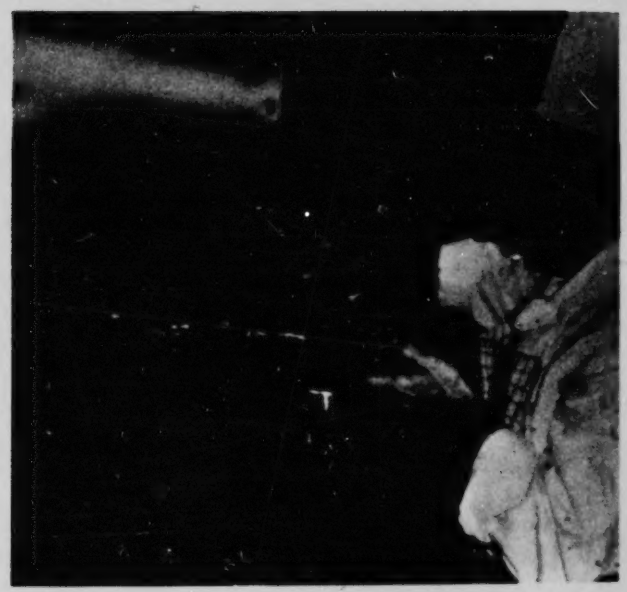


Figure 7b
Cutlets being hand fed into the Auto-Broiler

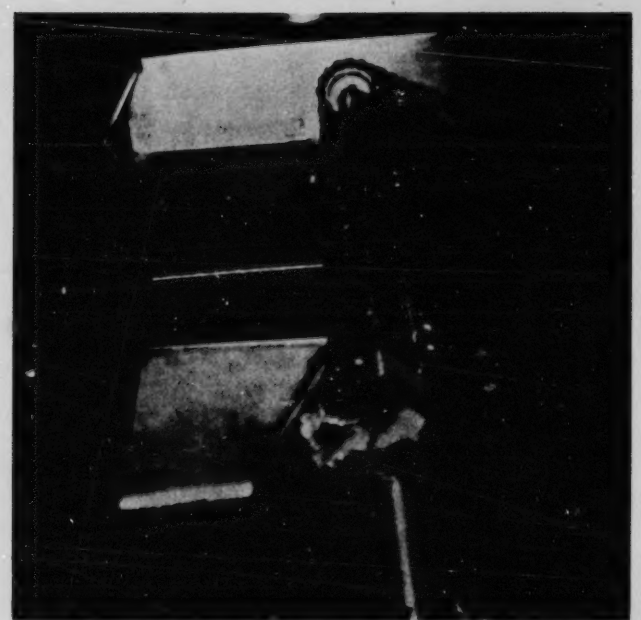


Figure 7c
Cutlets being unloaded from the Auto-Broiler into a bulk container stationed beneath the discharge opening.

total number of portions of each item required in a 28-day cycle in relation to the output of various pieces of equipment in the factory. Figure 1 (on page 4) presents a 28-day food production requirement for a hypothesized sample of twelve items for the purpose of illustrating the procedure of "sizing" the production facility. In this very simplified example, the maximum requirement is for 218 hours of convection oven time and 152 hours of steamatic operation. This is in excess of the 28 eight-hour days or 160 hours in a production cycle. Thus, two convection ovens and two steamatics would appear to be required if we were producing this sample menu. As a practical matter, the total menu, containing over 150 items, did create equipment demands in excess of the planning parameter of 160 hours production per cycle, and the center will be equipped with one hydrothermic unit, two steamatics, one auto-broil, one pyro-grill, four convection ovens, one tilting fry pan, one 79-gallon hydra-lift kettle, two 79-gallon blockettles, and two 59-gallon blockettles.

The single shift operation was adopted to serve the existing county system needs on the grounds that integration of additional facilities into the system could be accomplished by adding either overtime of additional shifts with a physical plant expansion design requirement limited to increasing the size of the freezer space. It is anticipated that additional facilities will be integrated into the Fair Acres Center in the future. This may include institutions such as the nearby Montgomery and Chester County Prisons (the counties adjoining Delaware County), the Pocotson Home (Chester County's geriatric center), and, potentially, the Delaware County Community College and the county school districts.

A comparison of the staffing requirements of the Fair Acres Food Factory with the alternative of six separate production centers is presented in Table 4.

Table 4. Comparison of Staffing Requirements

	Present Requirement	Planned Future Requirements
Administration	7	5
Production, Assembly and Warewashing		
Fulltime	99	48
Parttime (42) Expressed as Fulltime Equivalents	14	____
Total Fulltime Equivalents	120	53

System Operations: Production

There is a definite pattern of product flow established for optimum functioning of the Center which is shown in Figure 2 (on page 6). The basic units required for production are a receiving and storage area, an ingredient control zone, a preparation zone, and a cooking zone.

A typical flow pattern shows that the raw food product will be received, in bulk, in an adequately sized receiving area. Here the product is carefully checked, weighed, counted and inspected to assure that it complies with the written specifications and purchase requisitions for both quality and quantity. The receiving refrigeration (38° F) storage is sized to accommodate easily a two and one-half day supply of fresh and frozen food products to be processed. In addition, adequate storage is also required for dairy products as well as such frozen foods as ice cream and frozen juice concentrates. Ample dry storage, as well as the receiving cold storage zone, should be adjacent to an ingredient control zone.

In the ingredient control zone all ingredients needed for production will be prepared for use in accordance with standardized production recipes,

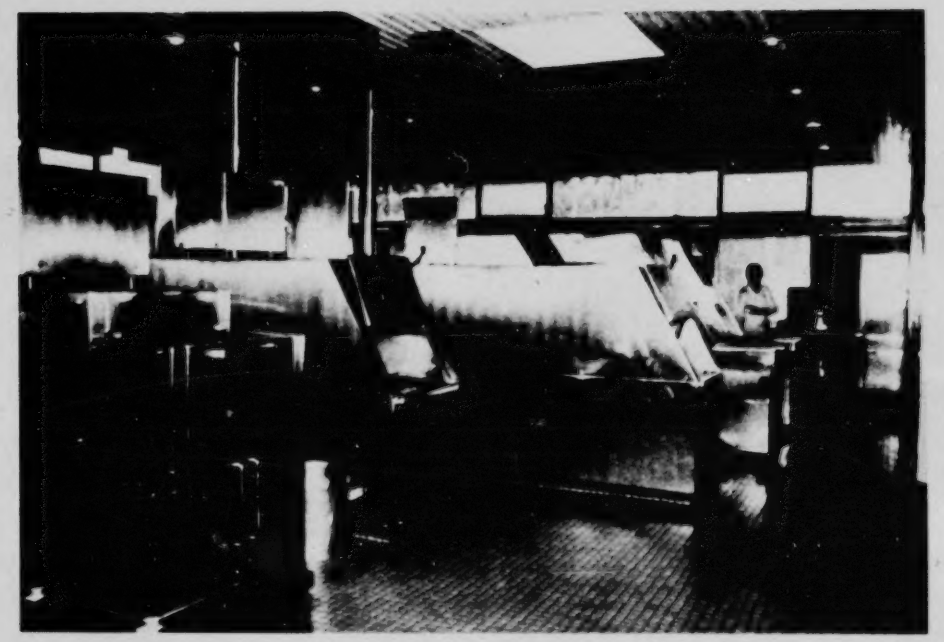


Figure 8
Cooking Street - The Loading End

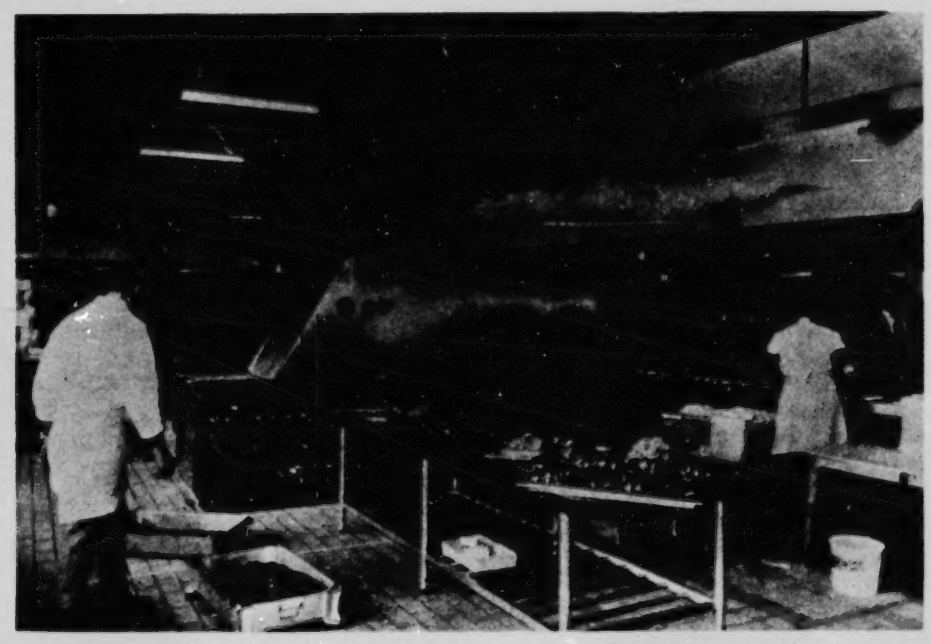


Figure 8a
The Cooking Street in Operation

many of which have been specifically developed for deep freezing. The ingredient control team is responsible for the weighing, counting, measuring and batch containerization of the ingredients for all the food items that are to be produced each day. All food products will be removed from their crates, boxes, cans and packages, and will then be containerized for transfer to the preparation zone. Some fresh foods, such as fruits and vegetables, may require washing prior to containerization. All trash will be disposed of in this ingredient control zone.

In the preparation zone, these ingredients and food products will then be mixed, according to a standardized recipe procedure. Other preparation operations, such as chopping, cutting, grinding, slicing and dicing will also be performed when required prior to the products being advanced to the cooking zone. Fresh food items such as salads and some desserts will be transported directly from this zone to the tray assembly and distribution zone.

Within the cooking zone, the food items will be processed through several types of thermal processing equipment required to complete the production process. These "transferautomats" are designed around the principle of continuous, small-batch cooking so that all like food items have the same cooking history. Many of these units are loaded automatically and do not require a fulltime operator, nor are any skilled cooks required on the "Cooking Street" of transferautomats. This method of food production assures consistent food quality with an absolute minimum of personnel requiring little special knowledge or cooking skills.

The need for skilled workers, who are at once scarce and expensive, is eliminated by the use of recipes which specify ingredients precisely; by a system design in which there is a separation between production work

Figure 9
Cofill System
This consists of three different elements that are designed to automatically portion, fill, weigh, elevate and transport away food containers from the automat, completely unattended.

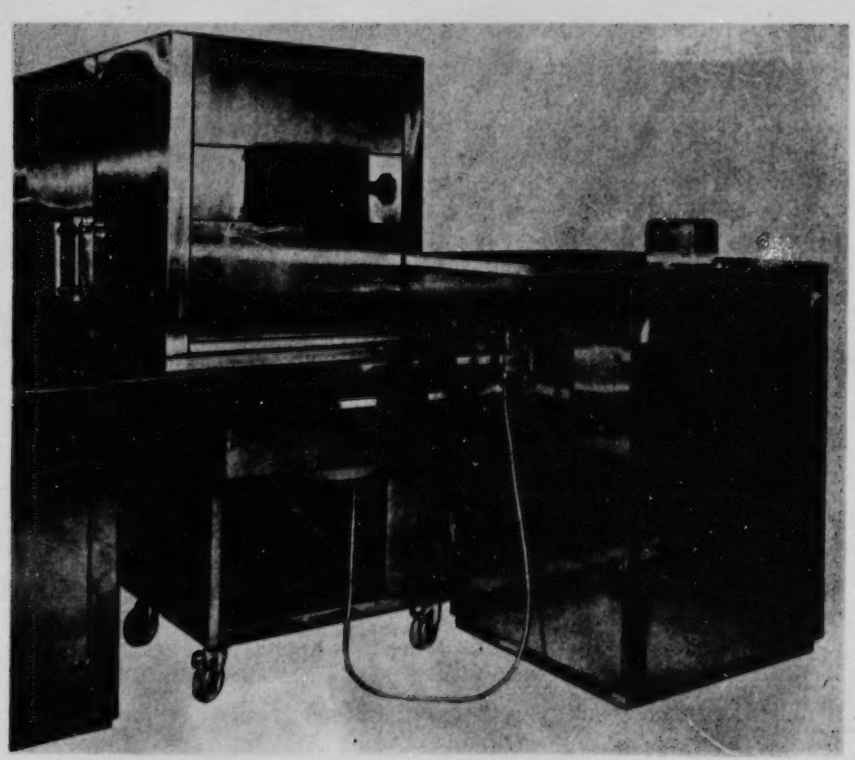


Figure 9a
Co-fill System Showing Rear of Portioning Unit and Transferring Unit

and assembling the correct ingredients in recipe prescribed amounts; and by a high degree of mechanization in the cooking process.

The center of the food production zone, called a "Cooking Street," (Figure 3, page 8) is made up of these automated pieces of equipment, which are described in some detail below. They include such continuous transferautomat units as the steamatic, the hydro-thermic, the pyro-grill, the auto-fryer and the auto-broil models. This equipment represents, collectively, the most highly automated system of its kind and is also the only totally integrated production system produced by a single manufacturer. The construction and design of the equipment is such that maintenance and repairs are minimal. In some installations the equipment operates continuously 12 to 16 hours daily, and is so reliable that the equipment is not made operational until twenty minutes before the start of production. The major portion of the control and electrical components are of United States manufacture and are readily available. A small spare-parts kit will be provided with each unit in the Fair Acres installation.

The Steamatic Unit (Steam Cooker). Fresh or frozen vegetables are loaded into the intake bin depicted in Figure 4, page 10. They are conveyed by the automatic loading system to a loading drum which portions the product into perforated stainless steel containers for cooking. The containers are mounted on a motordriven chain (Figure 4a) which can be adjusted to provide between 6 and 60 minutes of product exposure to the steam atmosphere. At the end of the cycle, the food is transferred to an unloading drum and from there to an automatic portioning device or a portable, tilting bulk service module which can be heated or not, as

required. Depending on the type of product and cooking time required, the steamatic can cook from 400 to 900 pounds of food per hour.

The Hydro-Thermic (Water Cooker). The food to be cooked is loaded into stainless steel wire mesh containers by hand or by means of a vibrator loading device (See Figures 5 and 5a on page 12). The containers are passed through water heated to just below the boiling point by a steam radiator jacket. When the cooking is complete, the product is rinsed with tepid water and unloaded into the desired type of serving unit, either stationary or mobile. Cooking time can be varied from as little as four

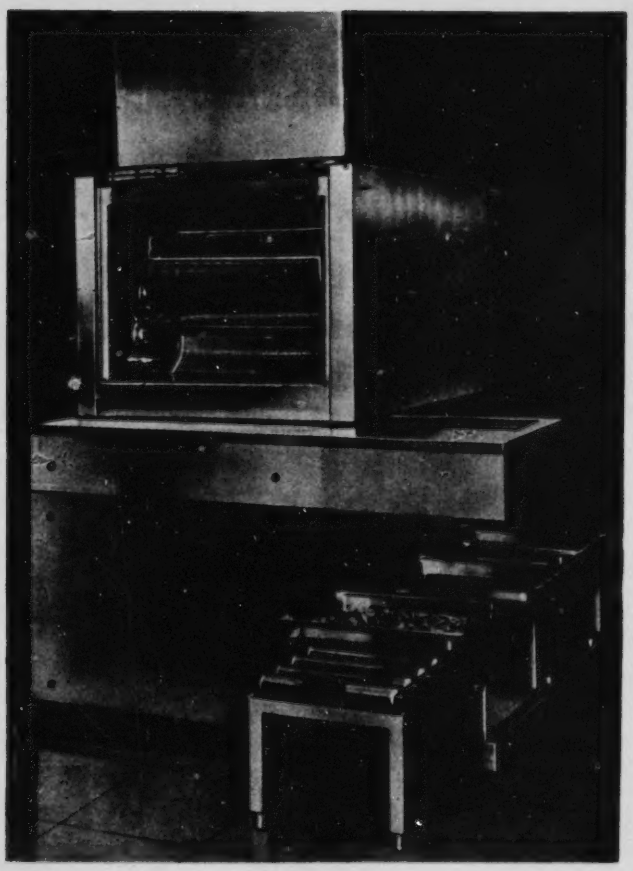


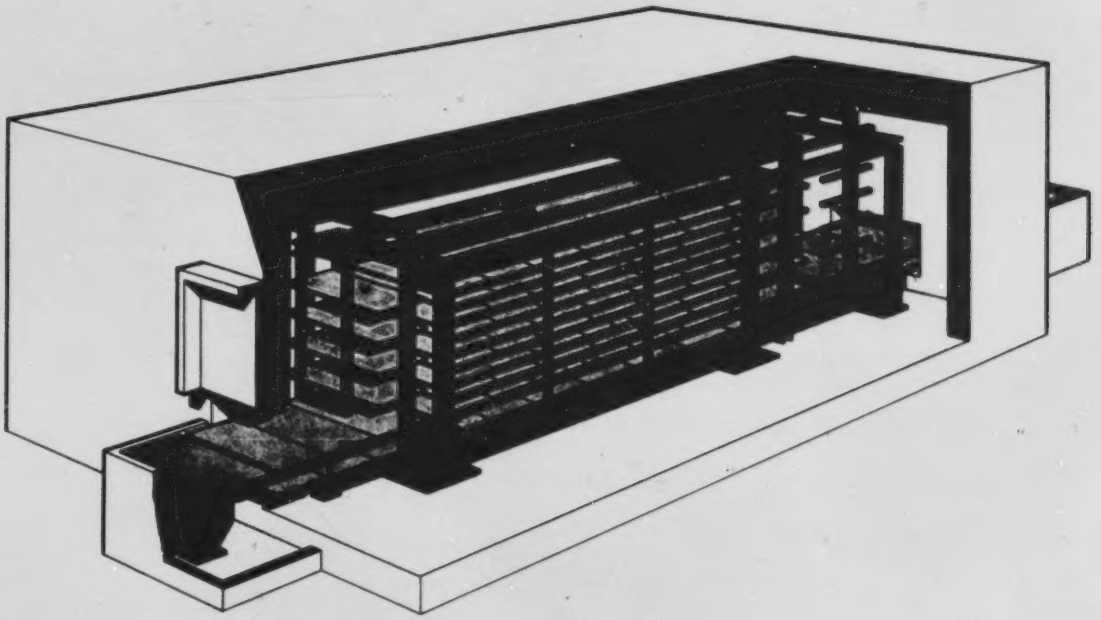
Figure 9b
Co-fill System Showing Unloading End of Automat; portioning unit and automatic scale, with the pan transfer unit removed.

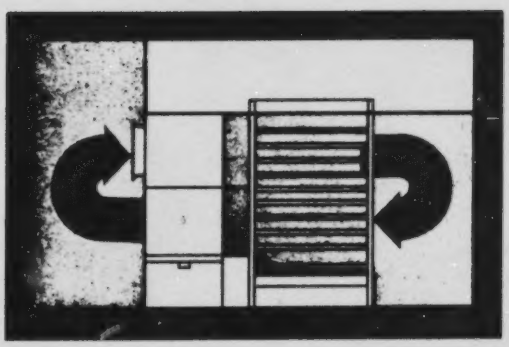
minutes to as much as 40 minutes. The hydro-thermic unit can produce 500 pounds of rice per hour with an average cooking time of 20 minutes; 600 pounds of pasta per hour with an average cooking time of 15 minutes; or 600 pounds of potatoes (whole, cubed, or dehydrated) per hour with an average cooking time of 15 minutes.

The Auto-Fryer Unit (Deep Fat Fryer). This piece of equipment is similar to the hydro-thermic in design and operation, but it uses cooking oil heated by electricity. The output of this unit is approximately 1700 portions per hour. It is designed for deep fat frying such items as potatoes, chicken parts, fish, and other breaded items.

The Pyro-Grill (Grill). Products to be grilled are fed manually into the grill surface (as in Figures 6 and 6a, page 14) and moved across the surface by a series of stainless steel bars mounted to a motor-driven chain. The speed can be adjusted to provide from 3 to 30 minutes of cooking time. At the center of the grill, the product is automatically turned over by a "flipper" mechanism to provide even cooking on both sides. The food is moved up an incline by the pusher bars before unloading, to allow excess fat to drain off the product. Production of such items as steaks, chops, grilled sandwiches, pancakes, and hash brown potatoes is between 1500 and 3000 portions per hour, depending on the product as well as the cooking time required. The grill can be converted to a shallow continuous fryer by adding 1-1/2 inches of cooking oil to the grill surface.

BBC-Contair-Froster Typ IV





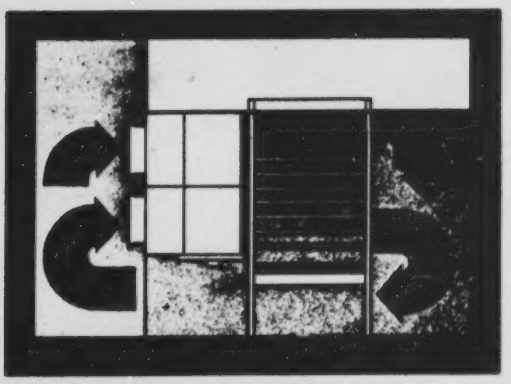


Figure 10

The infeed temperature of the product will be approximately 160° to 180° and the discharge temperature in approximately two hours and 15 minutes is 0° in the center of the container. This freezer operates on a principle of conduction and convection and the cost per pound is about 1.8¢ using a system of recirculating freon at -40° C.

The Auto-Broil Unit (Broiler). Items to be broiled are placed manually on a rod conveyor system. (See Figures 7a, 7b and 7c, on pages 16 and 17.) They are transported through infra-red heating zones with heating elements above and below the food items. The produce drops from the first conveyor to a second one, and finally to a third. Thus, the food passes through the infra-red heating zone three times before being unloaded into the desired container. Cooking time can be adjusted between 2-1/2 and 25 minutes. Steaks, chops, hamburgers, sausages, and chicken are produced at the rate of 800 to 1700 pieces per hour, depending on the cooking time.

These are the principle pieces of equipment making up a "Cooking Street." Figure 8, on page 20, shows the "loading end" of a Cooking Street while Figure 8a shows a Cooking Street in operation.

Packaging and Freezing

The cooked food from the Transferautomats is automatically weighed and portioned into disposable containers (Figures 9 and 9a on page 22, and 9b on page 24) and transported via a conveyor to the packaging equipment. Other food products, from the kettles, fry pans, and convection ovens will also utilize the transportation conveyor to the packaging equipment.

From the packaging area, where all containerized food products have been completely sealed, airtight, the containers will be loaded into a high production capacity automatic blast freezer manufactured by Brown-Boveri-York (seen in Figure 10 on page 26). This blast freezer, which operates hydraulically, is maintained at a temperature of 40° F, and employs the principle of conduction and convection of high velocity air

Figure 11
Food Being Portioned Into Individual Containers
Small batches of fresh cooked food are discharged from the unit into a holding container, where a kettle or portable bulk service wagon that is positioned directly under the transportation conveyor attached to the discharge end of the automats on the cooking street receives the finished product. The person who is portioning, therefore, has only to dip into the container of freshly prepared food and portion into the disposable plastic container shown on the conveyor belt passing in front of him.

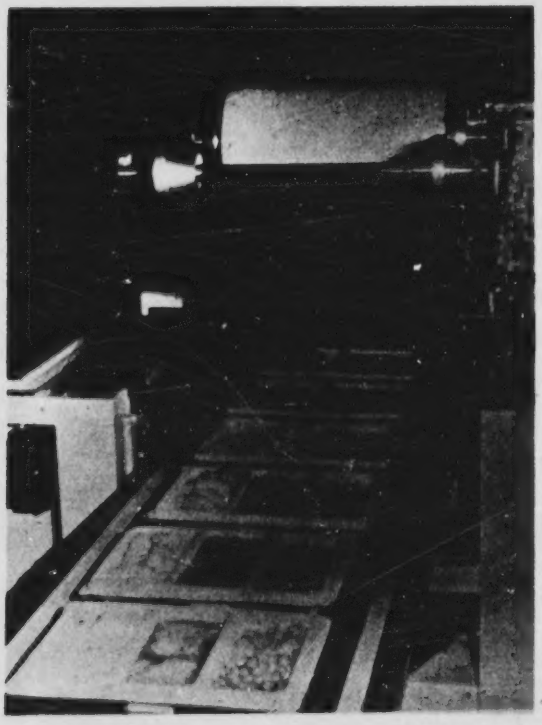


Figure 11a
Food Entering Packaging Unit
This photo shows hot portioned food entering the packaging unit, which seals the container in a partial vacuum before it automatically proceeds by conveyor into an automatic blast freezer.

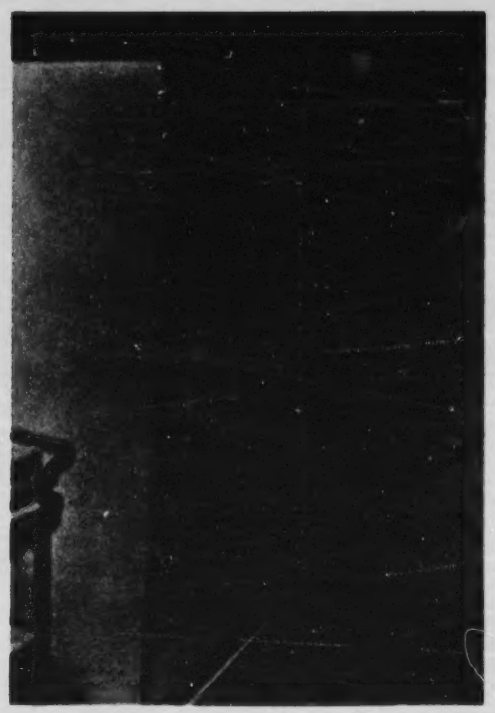


Figure 11b
Food Being Removed From Holding Freezer on Floor
A three day supply of frozen entrees is stored in each floor pantry at this facility in Berlin. Patients have the flexibility of selecting their meal two hours before the meal period.

Figure 11c
Food Being Placed in Convection Oven
These under-counter ovens are steam heated convection ovens and can reheat from frozen to serving temperature approximately 80 meals in 20 minutes. Entrees are then assembled into a compartmented permanent plastic tray, with all of the inserts being disposable.

over containerized food products, so as to reduce the temperature at the food core from approximately 165° F at infeed to 0° F at discharge, in only 2-1/2 hours.

Once discharged from the blast freezer, the bulk frozen food containers will be loaded onto specially designed mobile freezer rack modules, capable of accommodating 550 pounds of like food products. These modules will then be stored in a departmental system within the freezer food bank, at -20° F, thus allowing the entire inventory to rotate once each production cycle on a first-in, first-out basis.

System Operations: Distribution

A number of production and distribution systems are in use, depending on the requirements of individual facilities. In some cases a cook-serve-eat system is followed. Thus, for instance, at an atomic reactor research facility in Karlsruhe, West Germany, 7,000 scientists are fed in a central facility. Buses pick the scientists up from their widely dispersed buildings at this facility and bring them to a central dining area where the food comes directly from the cooking street to a cafeteria line. A food service staff of 18 feeds these 7,000 meals a day.

A cook-freeze type system, on the other hand, is used at the Uniklinik Berlin in West Berlin, West Germany. Here, food is portioned into individual servings (Figure 11), blast frozen (Figure 11a) and transported into a computer-controlled frozen food storage facility. Transportation of frozen meals to the patient floors is accomplished by a conveyor belt distribution system above the finished ceiling, which automatically directs the containerized food products to the proper floor kitchen where it is kept in a frozen condition until thirty minutes before the meal service

period. It is removed from the holding freezer in the floor kitchen (Figure 11b) and placed in a steam-heated convection (Figure 11c) oven which raises the food temperature to 160° F in approximately 22 minutes. The hot food items are then assembled into a compartmented, plastic, non-insulated tray containing the cold portions of the meal service and delivered to the patient. All food containers of the tray are disposable plastic with the silverware remaining in the floor kitchen where it is cleaned by an automatic undercounter dishwasher.

At Fair Acres, the cook-freeze type system will also be used, but here the product will be frozen in bulk form in 12" x 20" x 2-1/2-inch aluminum foil containers holding approximately 40 portions each. According to the daily menu and distribution requirements of the remote facilities, all food items for three complete meal services, lunch, dinner and breakfast, will be removed from the freezer food bank one day prior to use, and placed in automatic, controlled-environment, tempering units, specifically designed to raise the temperature of the food products from -20°F to +38° F within approximately eight hours and hold it in a 38° F refrigerated environment until required by the service personnel for assembly and distribution.

From the tempering units, part of the bulk food products will be transferred to bulk refrigerated or bulk convertible transport modules manufactured by Dynamic Systems, Inc. for distribution to such remote feeding centers as staff cafeterias, prisons, congregate feeding and children's centers or medical care facilities, where on-premise central cold tray assembly is more feasible.

The balance of the bulk food products will be loaded into portable, refrigerated, self-leveling dispensers, each holding approximately 600

FIGURE 12

TRAY ASSEMBLY AND MODULE DISTRIBUTION SCHEDULE

	SET-UP AND PRE-PORTIONING	FINAL TRAY ASSEMBLY	BREAK	DELIVERY TO POINT OF SERVICE	DEADLINE FOR DELIVERY TO POINT OF SERVICE	SERVING HOURS	RETURN TO CENTRAL FACILITY	DEADLINE FOR FIRST CTMs TO BE READY FOR TRAY ASSEMBLY
LUNCH	7:15 AM 8:00 AM	8:00 AM 9:30 AM	15 MINUTES APPROX. 9:30 AM 9:45 AM	8:30 AM 9:30 AM	10:30 AM	11:30 AM 12:30 PM	12:30 PM 1:30 PM	1:30 PM
DINNER	9:45 AM 10:30 AM	10:30 AM 12:00 NOON	30 MINUTES APPROX. 12:00 NOON 12:30 PM	12:30 PM 1:30 PM	3:30 PM	4:30 PM 5:30 PM	5:30 PM 6:30 PM	8:00 AM THE FOLLOWING DAY
BREAKFAST	12:30 PM 3:15 PM	1:45 PM 3:15 PM	15 MINUTES STAGGERED	5:30 PM 6:30 PM	6:30 AM FOLLOWING DAY	7:30 AM 8:30 AM	8:30 AM 9:30 AM	10:30 AM

portions of like items. These dispensers will then be positioned at the tray assembly conveyor, with an adequate number of stations to assure tray assembly speeds of from 20 to 30 trays per minute.

Fresh food components of the menu, like salads, some desserts, breads and beverages, will be stored in the assembly area and preplated prior to the final assembly of the trays in the assembly line.

All food items will be portioned at between 38 and 40° F and loaded into a refrigerated, convertible transport module that will accommodate up to forty complete patient meals and trays. All transport modules will be locked and delivered via truck to remote point-of-service areas. Each will then be plugged into an appropriate electrical power source and will automatically maintain all food products in a refrigerated condition until 45 minutes prior to meal service. At that time, the hot food portion of each meal will be simultaneously converted from 38° F to approximately 160 or 170° F before service to the patient. The cold portion of the meal on the patient tray will be maintained in a refrigerated state during the conversion cycle, at the end of which the hot portion, including the entree, soup or cereal, toast and hot beverage, will be added to the patient tray and served. This module is completely automatic and operates unattended, thus providing the facility with an opportunity for a controlled time for patient meal service--that is to say, the entire facility can be served simultaneously.

Following the meal service, a second or exchange set of convertible transport modules, loaded with fresh, preportioned, refrigerated food for the next meal, will be delivered from the Center to the remote point-of-service area by motor truck. At this time, the modules, containing soiled trays from the preceding meal, will be picked up and returned to the Food

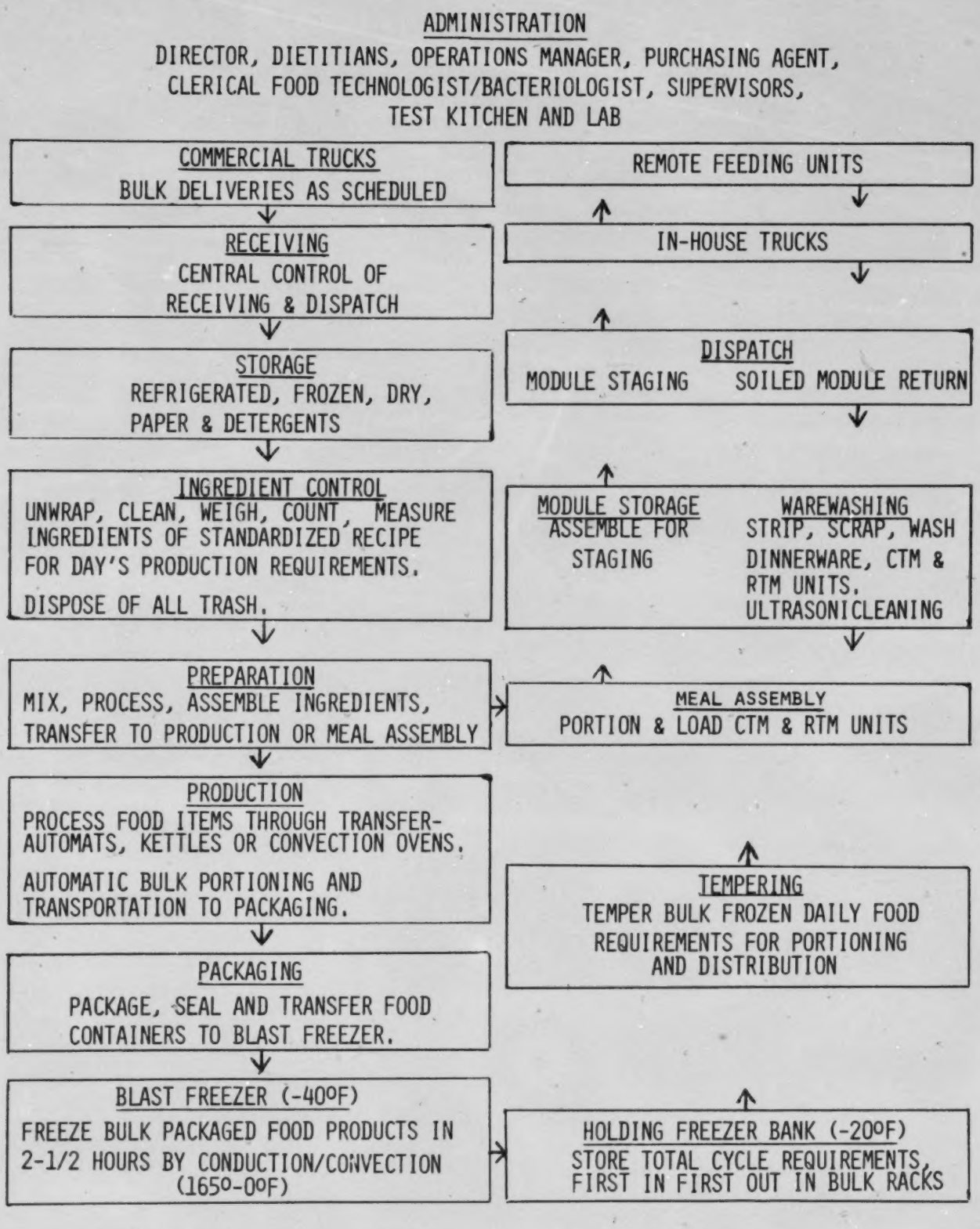

ADMINISTRATION
DIRECTOR, DIETITIANS, OPERATIONS MANAGER, PURCHASING AGENT, CLERICAL FOOD TECHNOLOGIST/BACTERIOLOGIST, SUPERVISORS, TEST KITCHEN AND LAB
COMMERCIAL TRUCKS
BULK DELIVERIES AS SCHEDULED
RECEIVING
CENTRAL CONTROL OF RECEIVING & DISPATCH
STORAGE
REFRIGERATED, FROZEN, DRY, PAPER & DETERGENTS
INGREDIENT CONTROL
UNWRAP, CLEAN, WEIGH, COUNT, MEASURE INGREDIENTS OF STANDARDIZED RECIPE FOR DAY'S PRODUCTION REQUIREMENTS.
DISPOSE OF ALL TRASH.
PREPARATION
MIX, PROCESS, ASSEMBLE INGREDIENTS, TRANSFER TO PRODUCTION OR MEAL ASSEMBLY
PRODUCTION
PROCESS FOOD ITEMS THROUGH TRANSFER-AUTOMATS, KETTLES OR CONVECTION OVENS.
AUTOMATIC BULK PORTIONING AND TRANSPORTATION TO PACKAGING.
PACKAGING
PACKAGE, SEAL AND TRANSFER FOOD CONTAINERS TO BLAST FREEZER.
BLAST FREEZER (-40°F)
FREEZE BULK PACKAGED FOOD PRODUCTS IN 2-1/2 HOURS BY CONDUCTION/CONVECTION (165°-0°F)
REMOTE FEEDING UNITS
IN-HOUSE TRUCKS
DISPATCH
MODULE STAGING
SOILED MODULE RETURN
MODULE STORAGE
ASSEMBLE FOR STAGING
WAREWASHING
STRIP, SCRAP, WASH DINNERWARE, CTM & RTM UNITS. ULTRASONICLEANING
MEAL ASSEMBLY
PORTION & LOAD CTM & RTM UNITS
TEMPERING
TEMPER BULK FROZEN DAILY FOOD REQUIREMENTS FOR PORTIONING AND DISTRIBUTION
HOLDING FREEZER BANK (-20°F)
STORE TOTAL CYCLE REQUIREMENTS, FIRST IN FIRST OUT IN BULK RACKS

Figure 13
Food Production and Distribution System Operation

Factory by the same motor truck. Therefore, the truck will always be traveling with a load in each direction. When the soiled modules are returned to the Food Factory, they will be routed to a central warewashing area, where they will be stripped, power washed, and made ready to receive the trays for the next meal service.

In the warewashing area, flatware and the most soiled dinnerware will be preprocessed through ultra-sonic cleaning units prior to normal dishwashing. This process provides almost rejection-free dinnerware at the completion of the total washing cycle. All ware will then be transferred to portable, multi-purpose, self-leveling equipment to be returned to the assembly area in preparation for the next meal assembly schedule.

A separate ultra-sonic cleaning unit is used for pre-cleaning bulk containers. This unit is designed to accommodate and process up to twenty full size (12" x 20" x 2-1/2") aluminum foil containers within ten minutes. This process enables the facility to recycle these containers several times, thus reducing the cost of use considerably.

Figure 12 shows the schedule of movement of food from the Center to the units and for the return of equipment to the Center from the units. The entire system is portrayed diagramatically in Figure 13.

Conclusion

The food production and distribution center described here closely resembles centers that have been in operation successfully in Europe for over fifteen years. In the immediate post war period, Europe had to replace much of its capital equipment destroyed during the war. The result was often a newer, better engineered facility--and this seems clearly to

be the case with the food production equipment developed at that time. In addition to the increase in output per man-hour and the elimination of the need for scarce craft skills, this system offers substantial advantages in purchasing. (A fuller discussion of these purchasing economies appears in Williamson, 7.) Because only one delivery in bulk is required rather than separate--and more frequent--deliveries to separate preparation facilities, suppliers are likely to offer highly competitive prices--and be willing to meet strict purchasing specifications.

The example we have examined involves an institutional facility. But movement toward centralization of food production among chain restaurants or in large hotels can clearly be facilitated by the flexible equipment and production system described here.

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THE MICHIGAN STATE UNIVERSITY
VEGETABLE PROCESSING CENTER

by

Ted L. Smith

and

Donald H. Ralph

THE MICHIGAN STATE UNIVERSITY VEGETABLE PROCESSING CENTER

Introduction

In 1969, a group of Michigan State University food service professionals began to design and build a central vegetable processing unit.* They recognized that the vegetable preparation involved in salads, soups, and entrees could be centralized in such a way as to eliminate disruption, control food waste, increase standardization, reduce the number of employees, and increase the salaries of the remaining skilled employees.

During an exploratory period in the summer of 1969, the group set up a miniature experimental processing operation in the kitchen of a campus residence hall in order to collect information on packaging, pricing, transportation, equipment needs, staffing, yields, processes, and production schedules. In addition, various members of the group visited nine centralized food processing plants throughout the Midwest to observe the processing systems in use there and to learn both the advantages and problems associated with operating centralized service units.

Subsequently the group concluded that the centralized preparation of vegetables in the Michigan State University food service could, in fact, lead to

1. more efficient use of the skilled food service personnel;
2. better food quality, waste control, and cost control; and

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* This article has been adapted from "A Food Processing Center Michigan State University" by Donald H. Ralph in Ted L. Smith (ed.) National Association of College and University Food Services Technical Bulletin (East Lansing, Mich., 1973). Photographs for this article were taken by Jack Thompson.

3. a larger selection of partially or fully prepared vegetables, which in turn would provide the operating units with flexibility and encourage creativity.

The group further discovered that it could minimize the cost of establishing the central vegetable processing operation by

1. designing a five-day-a-week processing and packaging operation that distributed pre-packaged, processed vegetables to the campus food service units via established food delivery schedules;

2. modestly renovating available space;

3. designing the business procedures for unit ordering and unit billing so that the new processing operation could be incorporated into the existing computerized food stores system; and

4. using, as far as practical, surplus equipment.

A Description of the Operation

The Michigan State University centralized vegetable center processes virtually all the vegetables used in salads, soups, and entrees that are used in the campus food service. It has substantially reduced food and labor costs by centralizing the tasks normally associated with vegetable preparation. The new system has also maintained, and even increased, food quality. The Michigan State system is not, however, perfect: Commercial processors are continually experimenting and innovating, and the degree of automation some of them have achieved extends beyond Michigan State's capabilities and present needs.

The functional components of the Michigan State system can be divided into four groups: vegetables, salad dressings, jello, and mixed salads. But this paper focuses primarily on vegetable preparation. Moreover,

the author concentrates on the unique systems for processing lettuce and onions, since lettuce has a notoriously short shelf life and both products have resisted commercial processing in the past. (Lettuce makes up by far the bulk of the vegetables consumed at Michigan State and is used in volumes far exceeding those of other vegetables.)

Facilities and Equipment

Michigan State's central vegetable processing operation acquired the "Central Services Building," an antiquated food stores building with refrigerated space. Much of the equipment incorporated into the new system was salvaged from existing operations or cannibalized from discarded machinery. The operation did acquire the following pieces of new equipment: one bag-heat sealer; one bagging hopper; one corer; one dewatering screen; one three-horsepower disposer; one five-horsepower disposer; one food blender; two hose stations; one four-inch hydro pump; one main processing table; one 140-quart mixer; one onion hood; one oscillating conveyor; two pallet trucks; 120 palletainers; one portable table; two produce trimmers; four spray rinse hoses; one trim table; one vegetable cutter; and one vegetable washer.

The produce trimmers have whirling replaceable blades that trim the butt or cap from fresh vegetables, leaving the operator's hands free to manipulate the produce. Two of these trimmers are mounted directly over the trim table and garbage disposal. The custom-built trim table contains a five-horsepower disposal to catch waste from the trimmers above. The disposal has an eight-inch mouth that allows lettuce leaves to enter directly without clogging the opening.

The vegetable washer (V-type washer) soaks and washes certain vegetables fresh from the field. The washer consists of a tank section with a rod-type conveyor equipped with cross-bar flights to raise the produce out of the tank. A set of spray jets, arranged over the upper part of the conveyor spray washes or rinses the produce. The operation begins when the produce is dumped into the water bath (which also cushions the fall and avoids damage). The produce remains in the soaking tank long enough to loosen all the soil. (The length of this stay can be regulated.) A final spray rinse hits the produce as it emerges from the wash tank and approaches the main processing table. These three adaptations have been made to the standard washer: (1) rubber fins, added to the cross-bar flights, increase the riser area; (2) a screen, added to the water overflow, keeps floating vegetable particles from the drain line; and (3) the spray jets have been raised to allow larger amounts of produce to pass beneath them.

The main, stainless steel processing table is 11 feet long and two feet wide. Its first 30 inches consists of a flat receiving area for the produce discharged from the washer. This first section contains a removable plate covering the access to the Waste King IND 3 disposer. The edge of the table has a flume that runs its entire length and carries waste to the disposer. A conveyor set along the table carries the vegetables down the table into a container either for additional processing or for the bagging stage. Three rinsing hoses with aerator heads and squeeze handles are mounted on this processing table. These spray heads provide additional washing capabilities.

The oscillating conveyor installed along the main processing table provides a gliding, gentle, smooth, uniform produce flow to accommodate,

in particular, fragile, easily bruised vegetables. The stainless steel surface that the food touches is free of crevices and joints; its corners are rounded; and it is, overall, sanitary and easily cleaned. It has few moving parts and no exposed belts, chains, or gears. And while it moves the produce quickly, it does not compact it.

The Urschel vegetable cutter dices, strip-cuts, and slices at capacities up to six tons an hour. By adjusting the slicer knife, removing various cross-cut and circular knives, and using special knife spacers, the vegetables can be cut in many different shapes. (The Urschel cutter appears as Figure 1.)

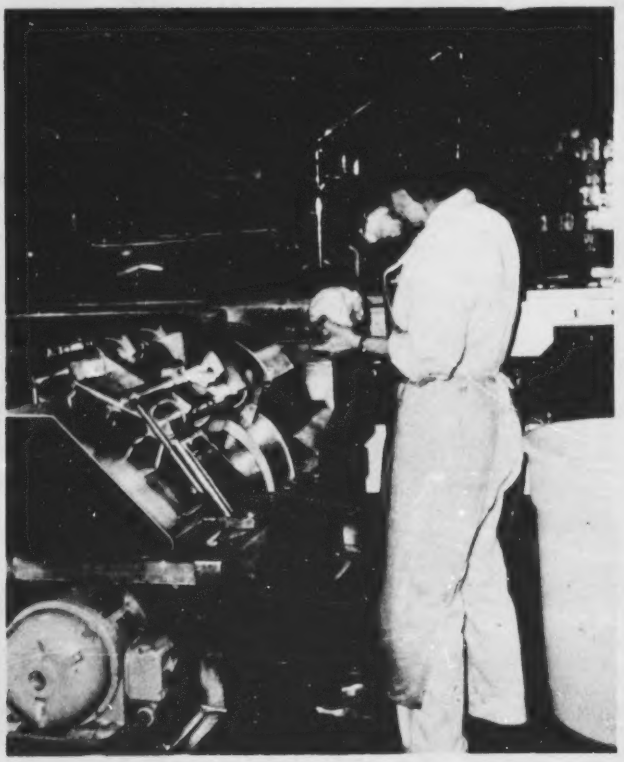


Figure 1. The Urschel Cutter

The four-inch hydro food pump uses water to elevate and convey pieces of produce in sizes up to three inches. This gentle, clog-free pump has bladeless impellers that prevent damage. Moreover, an anti-oxidant solution cushions, cleans, and coats the produce. This solution is subsequently recirculated by gravity, and a float control valve maintains minimum water supply requirements in the stainless steel feed hopper.

Polyvinyl choride piping transports the produce from the pump to the dewatering screen and returns the filtered solution. The pipe is light, inexpensive, and easily assembled.

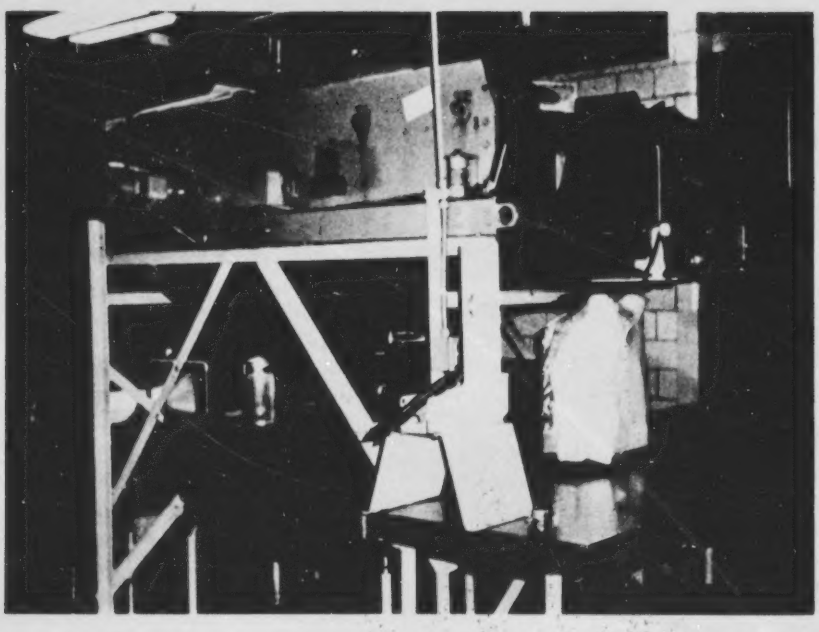
The vibrating dewatering screen can remove as much as 95 percent of the free water from the vegetables. A tank under the screen catches the antioxidant solution and returns it to the hydro pump for recirculating. A stainless steel, number 16 mesh, slotted screen prevents the loss of small but usable produce pieces without clogging. (Too fine a mesh would prevent the water from falling through; rather it would hold the water with a capillary action effect, and the water would move along the screen with the food.)

A bagging hopper at the discharge end of the dewatering screen catches, measures, and funnels the product into polyethylene bags that are heat sealed. This hopper is built of plexiglass and has a spring-operated trap door. The opening of the trap door can help shape a folded food bag, attached by a wire bag wicket. (Two views of the bagging operation appear as Figure 2.)

The corer reams cabbages with a pear-shaped knife, while a depth stop prevents excessive waste and serves, as well, as a safety device.

Two hose stations are used to clean the equipment. These wall-mounted units can reach the entire center, including the dock area. One

Figure 2. Two Views of the Bagging Operation



of the units automatically injects a detergent-disinfectant into the hose line for effectively cleaning, disinfecting, deodorizing, and rinsing.

Palletainers are open steel wire mesh pallets. They can be handled by a fork lift and safely stacked to save floor space. They have side gates so that their contents can be counted without disturbing the stacked units. These palletainers are used both in storage and delivery. They eliminate sanitation problems, promote product visibility, and cut fiberboard box expenses. In addition, the open mesh allows air to circulate freely, which provides a greater cooling surface.

The pallet truck moves the wooden pallets on which the produce is received and delivered.

The heat-sealed polyethylene bags used for the products processed at the vegetable center prevent excessive dehydration. The bagged product itself is cooled, and then a cool, humid atmosphere is maintained around it. The cold, antioxidant solution serves nicely--except for cabbage which absorbs water readily and must, therefore, be kept dry.

The poly bags used in the operation are two to three mills thick and are purchased on rolls or on wickets. The wickets used in the operation are hung by holes through a flap and are thus rendered self-opening. The front bag is always open to receive the product. The wicketed bag receives the product from the dewatering screen. Here a hopper effects volumetric filling. As the doors of the hopper open, they act as guide arms to shape the open bag. Other bags are placed on a holder on a scale. After the product has been bagged and heat sealed, it is placed on a palletainer. (Only onions can be put back in their original containers.)

A Discussion of the Preparation Processes

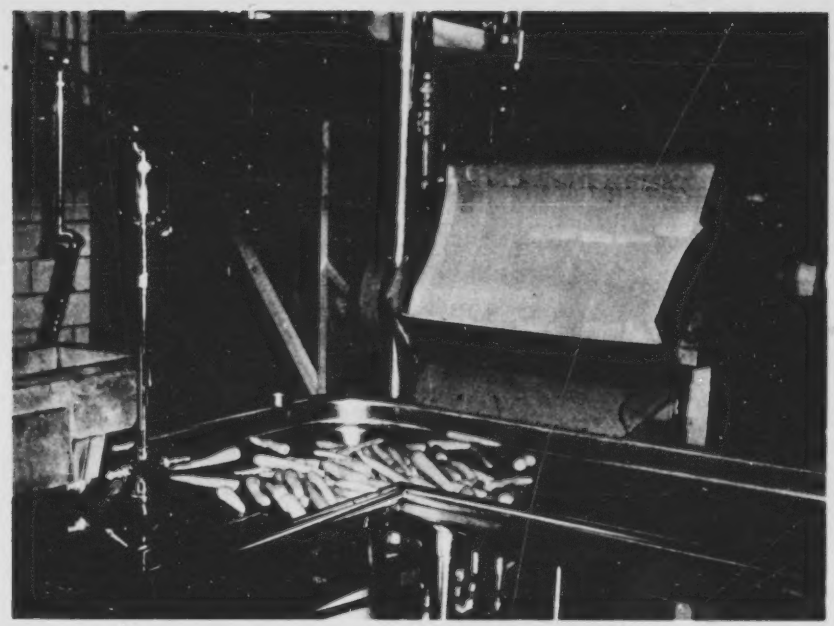
The Michigan State vegetable processing operation permits vegetables to be processed and delivered to the campuswide food services on the same day. Produce arrives at the center four times a week and is processed on the next working day. The processing follows this general pattern:

First, roller conveyors bring the vegetables from storage to the operation. The conveyors provide a steady supply of vegetables at a convenient height.

Second, the produce is trimmed, and any unusable scraps are discarded. The trimming occurs either at the trim table or the vegetable processing table, depending upon whether or not the produce must be pre-washed. Lettuce is fed directly into the Urschel food cutter. (The trimming operation is depicted in Figure 3.)

Figure 3. The Trimming Operation

Figure 4. V-type Vegetable Washer



Third, the produce that receives a pre-wash is placed in the V-type vegetable washer, pictured in Figure 4. The produce is soaked so that the soil is loosened and easily removed in the powerful spray system at the upper end of the conveyor. The conveyor raises the produce out of the tank and deposits it on the preparation table.

Fourth, on the preparation table, the produce is hand-inspected. Any bad spots are removed, and peeling can be done at this point. Overhead water sprays are available for hand rinsing. A "trough-veyor" carries the waste to a disposal.

Fifth, the finished product is placed on a conveyor which carries it to the end of the table for bagging, provided the product needs no further processing. If it does require more processing, it is shunted to the appropriate container.

Cut lettuce or celery falls from the Urschel food cutter into the hydro pump and is piped in the antioxidant solution to a dewatering screen. This pump will handle up to three-inch solid pieces. Besides coating the product with an antioxidant and transporting it, this step water cushions and cleans the vegetable pieces. At the dewatering screen, the excess water is quickly removed and recirculated. The produce is then placed in the poly bags through the drop-type hopper ready for heat sealing. All bagged produce is placed in the palletainers.

The more specific processing methods are described in the following paragraphs. These processes have been arranged into seven categories: trimming, washing, coring, hand-cleaning, cutting, antioxidant treating, and dewatering. In addition to these seven processes, which vary for the different vegetables, all the products must be conveyed to the beginning of the process, and all the packages must be removed at the conclusion. Table 1 depicts a breakdown of the processes required for each vegetable.

Trimming

The Hydrout produce trimmers remove a minimum of material from the ends or caps of the vegetables. Then the loose leaves are removed manually. An operator must develop the right "touch" and must learn not to remove loose leaves while holding the lettuce near the face of the trimmer. Spots may be removed from head lettuce by lightly brushing the head against the trimmer blade. (The operation is depicted in Figure 3.)

TABLE 1

VEGETABLE PREPARATION PROCESSES

Product	1 Trim	2 Pre-Wash	3 Core	4 Clean	5 Cut	6 Treat	7 De-water
Cabbage, whole			X				
Cabbage, cut			X		X		
Endive	X			X	X	X	X
Lettuce, whole head	X	X	X	X		X	
Lettuce, cut head	X		X		X	X	X
Onions, green	X	X		X			
Onions, span. yellow whole	X	X		X			
Celery, whole	X	X		X			
Celery, chopped	X	X		X	X	X	X
Radishes, whole				X		X	X
Radishes, sliced				X	X	X	X

Washing

The washer in the Michigan State vegetable process has been designed for produce that is relatively easy to clean. It readily removes field dirt. The washing process begins when the produce is dumped into the cushioning water bath. It proceeds through the spray system at the upper part of the conveyor and is finally dumped onto the main processing table.

Coring

Cabbage coring is done by the Hydrout corer. The cabbage head is centered on the hole in the guard plate and then pressed forward. A maximum depth-stop adjustment prevents over-coring.

Hand-cleaning

This step can be performed either at the main processing table or at one of the side work tables. It includes such operations as trimming green onions or radishes, trimming celery, inspecting head lettuce for bad spots, spotting carrots, and cleaning and peeling onions.

Cutting

Produce cutting is accomplished in one of three ways: by hand, with an automatic Urschel cutter, or with the semi-manual Halde vegetable mill. The Urschel cutter uses a "continuous motion" operation that permits a free and steady flow of produce through the machine. This steady flow contributes to its high capacity. The Urschel cutter is used primarily for lettuce and celery where the shape of the cut is not important and where a large volume of produce must be processed. (It takes some time to change the knife and clean the cutter.) The quality of the cut depends largely on the way in which the food comes to the machine. If large quantities of raw vegetables are dumped into the feed hopper, serious overloads followed by periods of idleness result. A steady flow, then, produces the most desirable finished product.

The Halde vegetable mill uses different combinations of blades according to whether the vegetables are soft, fibrous, or irregularly shaped. It is fed either by a free-flow hopper, a straight-feed hopper,

or a whole head cabbage insert. The vegetable mill is used when a small amount of food has to be processed, or when, in the case of carrots, the direction of the cut is important and the feed is not continuous.

Employees resort to hand cutting only when it is impractical to set up and clean a machine for the small amount of food to be processed. Endive, for example, is usually cut by hand.

Antioxidant Treating

In the Michigan State system, antioxidant joins the produce in the hydro pump. When it becomes impractical to run a vegetable through the hydro pump--for example, when only a small amount of produce has been placed in perforated pans--it is dipped by hand into a tank of antioxidant.

Dewatering

The dewatering step drains the antioxidant from the produce. If the vegetable has been dipped into the antioxidant by hand, its perforated pan can be turned and rested on the edge of the antioxidant tank until the produce drains thoroughly. The dewatering screen described previously is used for all products treated and conveyed through the hydro pump.

Advantages of the Michigan State Vegetable Center

Lettuce Processing

By far the most heavily used vegetable, lettuce, can be chopped and bagged at the rate of a case a minute. Two employees remove the

head from the case, trim off the end, remove the outer leaves and feed the lettuce directly into the Urschel food cutter. The chopped lettuce is flumed in an antioxidant solution to the dewatering screen where the solution is returned to be reused and the chopped lettuce is vibrated into the bagging hopper. An employee opens the trap door on the hopper filling a wicketed bag on a scale. A third employee heat seals the bag and places it in a palletainer. The entire operation appears schematically in Figure 5.

Onion Peeling

The Michigan State center has developed a unique way of peeling onions. After the onion ends are trimmed on the produce trimmer, they are washed in the V-washer. Next the skin is scored with a box opener knife. Each onion is then fed into a specially designed onion hood, through a large plastic tube. The hood, shown in Figure 6, resembles a hospital incubator except that it can be used by two employees at the same time. These two employees stand with their arms inside the hood and pick up the onions from an opening in the top of the feed tube. They hold the onions under a jet of air that blows the skin off. Thus peeled, the onions are inserted into another tube that deposits them on the oscillating conveyor. This conveyor carries them to a poly-lined net onion bag held in a bag holder and resting on a scale. Along the front edge of the processing table on which the onion hood rests is a trough that carries the waste to the disposal.

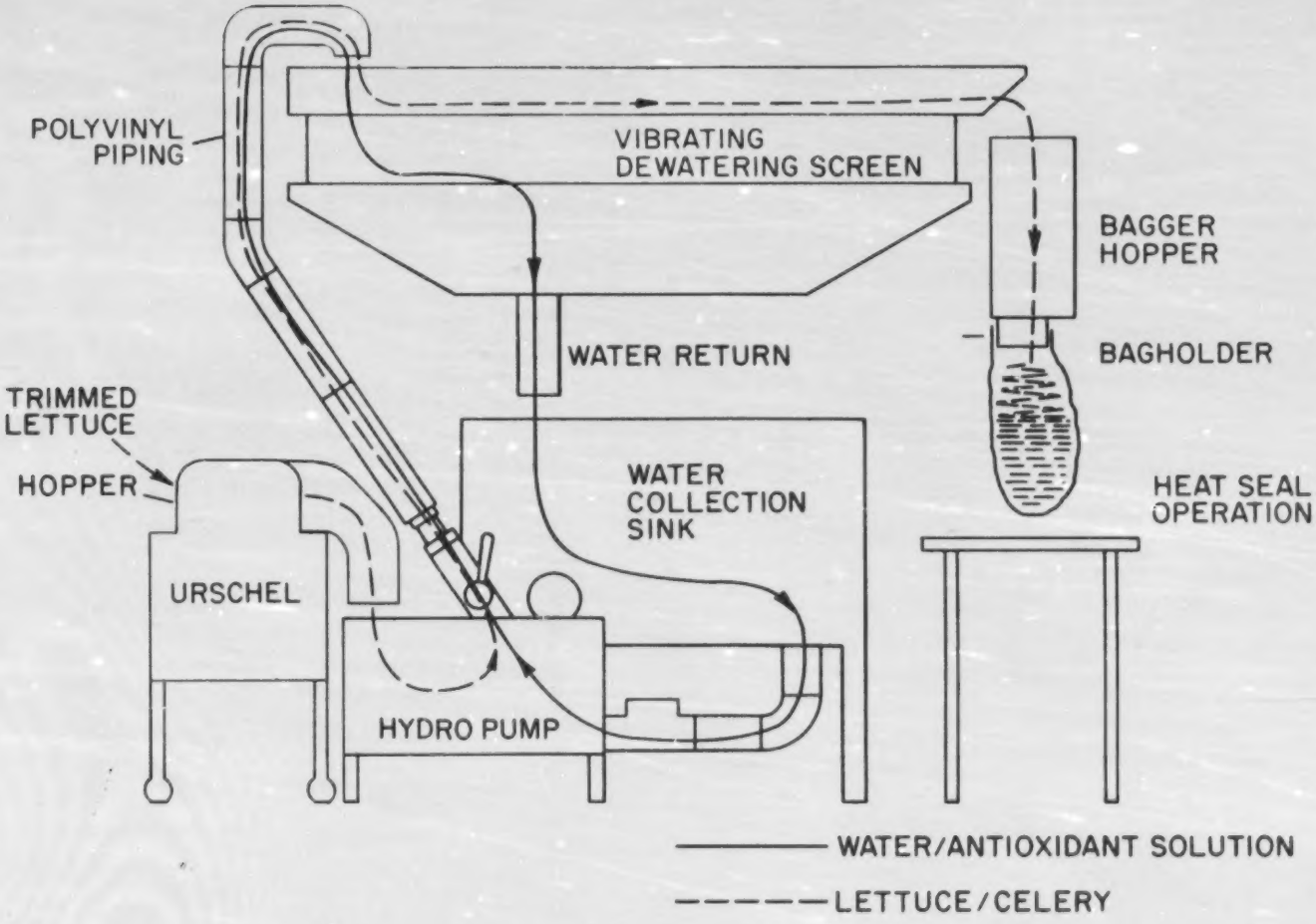
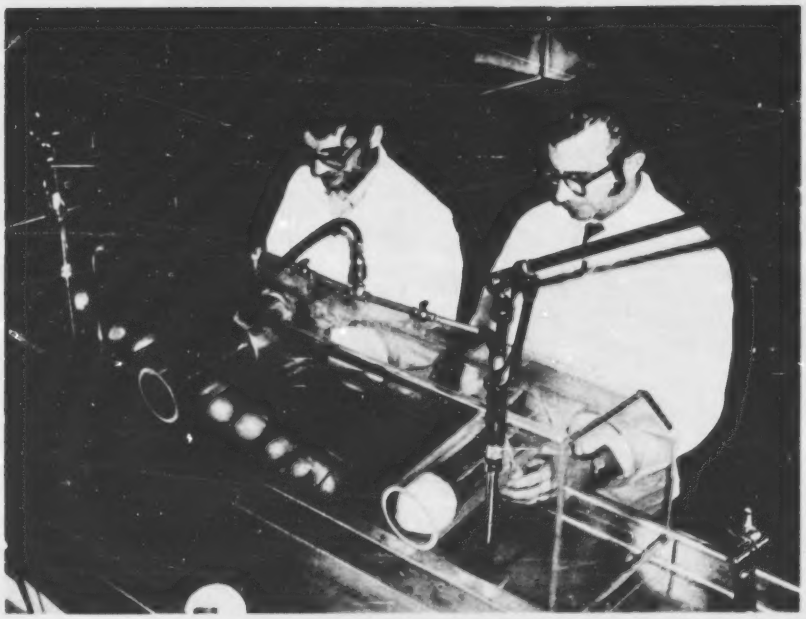


Figure 5 MICHIGAN STATE UNIVERSITY LETTUCE OPERATION

Figure 6. The Onion Hood



Salad Dressings

Salad dressings are mixed at the vegetable processing center instead of at each individual kitchen. Thus Michigan State need not purchase premixed dressings. Even though the center uses 11 different salad dressing recipes, it gains considerable savings through its ability to purchase salad dressing ingredients in four-gallon cartons rather than gallon jars. After mixing in the 140-quart mixer, the dressing is pumped off the bottom of the tapped mixing bowl into two-quart poly containers with snap-on lids. When the fill valve closes, the product is circulated through a specially designed relief valve back to the bowl. The sealed salad dressing is delivered to the food service units via the same palletainer system used for

the produce. At the various kitchen sites, the snap-on lid is removed and the dressing is ready to be served. The salad dressing operation appears schematically as Figure 7.

Mixed Salads

The Center also prepares a wide variety of mixed salads and eliminates the usual kitchen operation. Nine varieties of salads are available, including coleslaw, potato salad, macaroni salad, and a vegetable relish. The cooked ingredients are prepared in the kitchen area of the Center. A Leland double-action food blender is used for mixing the salads. They are packaged in either 10-pound plastic containers or 30-pound poly-lined boxes. The containers are shipped via the palletainer system.

Gelatin Salads

The Michigan State Center is in the process of introducing gelatin salads and desserts to its present line of products. The gelatin will be prepared in an 80-gallon cooker-mixer-cooler kettle. Fast cooling is permitted when cool water circulates in the kettle's jacket. The cooled product is pumped to a filling unit for dispensing into the containers. The addition of appropriate fruits takes place at this point. The package used is round and plastic; it measures 3" deep and 12" in diameter; and it has a snap-on lid. The sealed containers are delivered to the units via the same palletainer system used for the other products. In the service unit, the molded gelatin is turned onto a round service plate. A self-service system is then used for actual food distribution.

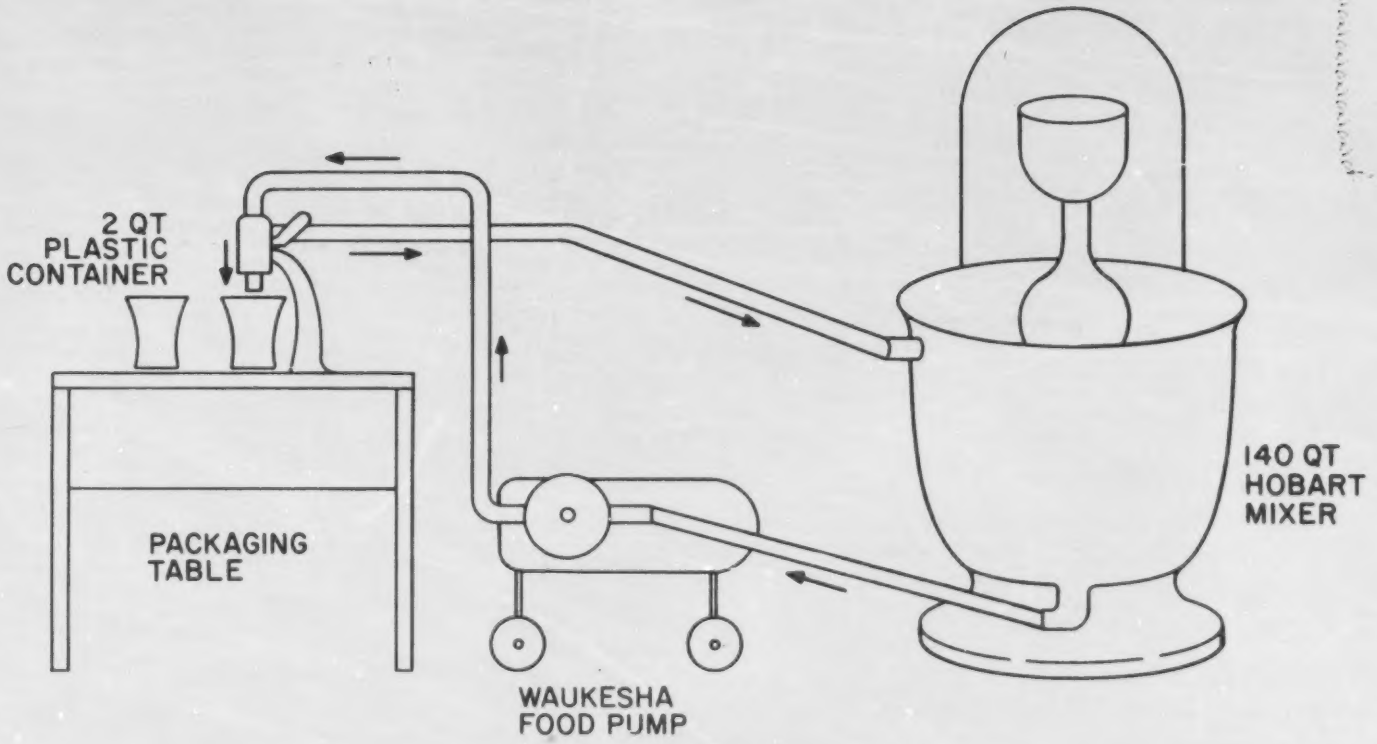


Figure 7 MICHIGAN STATE UNIVERSITY SALAD DRESSING OPERATION

Control Factors

Bag sizes reflect the yield expected from standard purchase units. For example, a 50-pound bag of onions should yield about 45 pounds. Thus the employee who orders food for the kitchen had no new size units to learn and is assured of an exact yield. The supervisor at the vegetable processing center has no difficulty ordering produce because a unit of unprocessed vegetables will yield a standard unit of processed vegetables. In short, the system provides close control over yields and food in stock.

Moreover, a cook can remove processed vegetables from storage without calculating what their yield will be. (In the past, if, for example, 15 pounds of unprocessed vegetables were removed from storage and the yield proved to be a little over or a little under the required amount, waste resulted. The processed vegetables provide control over recipe yields and provide standardization as well.)

Some products are processed in ready-to-use units. There are four 7-1/2 pound bags of chopped lettuce in a case. Other ingredients for a tossed salad, like shredded carrots, sliced radishes, shredded red cabbage, and chopped endive, are packaged in four-pound bags. A 7-1/2 pound bag of lettuce and a pound of any three of these other vegetables make a tossed salad. Thus, for every case of chopped lettuce, cooks can order three bags of any of the other, colorful ingredients.

Conclusion

The Michigan State vegetable center processes an average of 381.5 tons of vegetables per year. It also produced another 91 tons of mixed salads, and gelatin salads. Moreover, vegetable preparation costs fell

by 55.6 percent with the opening of the center. At present, Michigan State serves 285,000 meals every week. The following table depicts the weekly production averages and yields of the vegetable processing center:

TABLE 2

Vegetable Processing Center Weekly Production Averages

Quantity	Product	Yield
2,020 lbs.	Cabbage	81 percent
1,595 lbs.	Carrots	79 percent
2,880 lbs.	Celery	75 percent
345 Cs.	Head Lettuce	71 percent
1,145 lbs.	Yellow Onions	90 percent
1,470 lbs.	Spanish Onions	91 percent
389 lbs.	Radishes	96 percent
50 lbs.	Green Onions	67 percent
395 gal.	Salad Dressings	
3,270 lbs.	Mixed Salads	

It is true for Michigan State, as it is for the entire food service industry: Budget constraints are forcing totally new approaches to the design and implementation of food processing. If employee productivity is to be increased, food and labor costs minimized, and acceptable food quality maintained, decentralized food processing procedures common to all or nearly all units can often be profitably centralized. This centralization requires a systematic approach typified by the Michigan State vegetable processing center.

Moreover, the workforce that accomplishes this food processing is minimal. The Michigan State University vegetable processing center currently employs one production supervisor, nine fulltime produce processors, one delivery and stockroom person, and only an occasional part-time student helper.

MICROBIOLOGICAL QUALITY CONTROL
FOR
CENTRALIZED FOOD PREPARATION FACILITIES

by

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MICROBIOLOGICAL QUALITY CONTROL FOR CENTRALIZED FOOD PREPARATION FACILITIES

Introduction

In the traditional restaurant setting, food moves rapidly through channels from preparation to consumption with limited holding time for prepared foods. But, in centralized preparation, the holding period is extended at several points in the system--storage time after processing, distribution, and in the retail outlet. Traditional restaurant food safety and sanitation practices have become outmoded in this new setting. In centralized preparation, an outbreak of food poisoning could affect numerous patrons and would consequently be disastrous to the operator. Therefore, the idea is intolerable.

Since extension of shelf life is of prime importance in centralized preparation, in addition to controlling food poisoning microorganisms, the food factory also becomes involved with the control of microorganisms that grow and spoil food at refrigerator temperature. Safety limits and procedures for holding foods become standard operating procedure, and sanitation programs operate on a new higher plane. In fact, sanitation occupies about one-third of the work time spent in food processing plants. (24) The controlling mechanism is called "microbiological quality control" and is part of the facility's quality control program.

This control has long been used in the dairy industry and in food processing plants.

The purpose of this paper is first of all, to, review methods of microbiological testing by way of explaining some common terms; secondly, to discuss the reasons for microbiological control; and finally, to discuss a microbiological quality control program in its application to a centralized food facility.

Throughout this paper the dairy industry is used as a model because this industry has the best overall record of food safety. In addition, it deals with a highly perishable product and its method of distribution has also changed so that it has been necessary for the industry to extend the shelf life of its products. It has worked out methods of control that are economically feasible and provide meaningful information to management.

Microbiological Tests Used In Food Production Systems

The microbiological quality control laboratory in the food plant routinely uses tests and collects a log of data from these tests. Because of the expense and the time consumed in performing them, a minimum number of tests are used that, however, still provide management with sufficient information affecting shelf life and food safety. Rather than measuring visually, the laboratory personnel take samples of the food or swab tests of equipment and make a microbiological measurement of sanitation standards.

There are two tests routinely used by food plants: (1) the Standard Plate Count (SPC) and (2) the Coliform Count. These two tests are called "indicator" tests. They do not find the microorganisms that cause food-borne illness. While there is no direct link between food-borne disease and numbers of microorganisms, if large numbers of bacteria are shown to be present, it is possible that unsanitary practices have taken place.

Hazardous foods or foods with special problems may determine the necessity of employing such tests as Salmonella, Staphylococcus aureus, yeast and mold counts, and other less frequently used tests.

Laboratory costs and time constraints account for the fact that all the tests available can be used. It has been found by the dairy industry that bacterial monitoring using the SPC and Coliform tests are sufficient to produce a safe product if the tests are properly interpreted and if followup is maintained.

Standard Plate Count

The Standard Plate Count (SPC) is also called the Aerobic Plate Count (APC) or Total Plate Count. This test measures the number of aerobic bacteria in a sample gram of food. The number of bacteria will vary depending upon the food sampled. Most foods can be considered undesirable if they contain a large number of microorganisms. "High viable counts often indicate contaminated raw materials,

unsatisfactory sanitation, or unsuitable time/temperature conditions, during production or storage, or combination of these." (38) (The exception to this are fermented foods which naturally contain up to millions of microorganisms per gram.)

Swab Tests and Agar Plate Counts are variations of the SPC. These tests are used to count the number of viable microorganisms on equipment. They are often used before and after sanitizing to check the effectiveness of the cleaning program. Sometimes they are used regularly, or they may be employed when there are microbial problems.

Coliform Count

In the coliform test, the food sample is cultured in a specific media in which only a special group of microorganisms called coliforms will grow. Coliforms are found in the intestinal tract of man and animals, as well as in the soil. Their presence in food could indicate that the food may also have been contaminated with disease-causing microorganisms from an intestinal tract. So, rather than looking for specific microorganisms, the coliform group is used as an indicator. Since these coliforms are also found on plants, however, there are tests to determine if the coliforms are of plant or intestinal origin. But again, it is costly to make this differentiation routinely. The problem is overcome by knowing the normal range of coliforms in a particular food. (For example, coliforms of plant

origin are high in strawberries and bananas, but should not even occur in pasteurized milk, since the heat of pasteurization destroys them. As a result, producing a strawberry or banana ice cream with a low coliform count is a real problem--a problem of interpreting coliform numbers.)

The greatest advantage in using the coliform test is that coliforms are easily destroyed by heat: They are readily killed by pasteurizing and heat treatments. Therefore, if the coliform test is performed after a heat treatment or pasteurization and coliforms are present, the product has been contaminated--usually by plant personnel or by contaminated equipment. Or the heat treatment may have been ineffective.

Interpretation of Microbiological Tests

After the tests have been performed, they are accumulated and reviewed with regularity. Each test is recorded according to where the sample has been taken. The test results will record numbers of bacteria, which may vary from none to millions per ml or gram of sample. It is important to know, then, how many bacteria to expect in each product, and this number will vary from food to food. (See Appendix A, "Numbers of Bacteria.")

Once the normal number of bacteria is known (and these normal range of numbers are gained by cumulative experience with good manufacturing practices) a number that suddenly jumps is a danger signal that something is going wrong.

For example, in the table below, raw milk has been tested with the Standard Plate Count. The legal limit is 100,000 bacteria per ml for premium milk, and if two out of three tests are over 25,000, the supplier loses his premium payment for the milk that month.

Table 1

Farm Suppliers of Raw Milk

Standard Plate Count

Tests	Farm A	Farm B	Farm C	Farm D	Farm E	Farm F	Farm G	Farm H
1	4200	1700	9900	4300	5700	5800	10000	4800
2	9300	13000	7600	3200	10000	7400	8500	26000
3	7600	14000	14000	4100	6500	62000	9700	36000

Of the eight suppliers tested, one farm (Farm H) exceeded the premium limit (two tests exceeded 25,000 bacteria/ml.) and lost his premium payment. For Farm B, note that the level of bacteria is over the state requirement. Not only would this farm lose the premium, but it could be visited by a state inspector to see if the problem had been corrected. Note that the milk has already gone through the system even though there are occasional high counts. High counts do not necessarily indicate a health hazard, but they often do indicate unsanitary handling. The enforcement of low counts has effected better sanitation practices in the dairy industry resulting in a longer shelf life for milk products.

In the centralized food preparation facility, tests on incoming raw materials would be similarly interpreted. The foods are not rejected because they have probably gone through the system, but the supplier is informed that his bacterial numbers are unacceptable and if the numbers do not improve, the supplier may need to be changed. The numbers of bacteria, then, are historical data, even though they may exceed high limits at times. The followup of the tests, then, becomes the most important result of the testing program.

Microbiological records should also supply information showing the personnel responsible for test results. Table 2, taken from a Pennsylvania Dairy Plant Laboratory, records the names of the workers responsible for processing and sanitizing. In the followup, the worker is informed when his counts are unacceptable, and he must subsequently intensify his sanitation efforts in order to lower the counts. For example, in the table, on March 1, the skim milk showed a high count. After the restuls were reviewed by the lab supervisor, a personal visit was made to Robert and Gordon, the result of which was more attention to the sanitation procedures.

Table 2

Holding Quality Test with Job Responsibility

Date	Product	SPC	Mold Count	Sterilization by	Processing by
3-1	Homo Milk	300		Robert	Gordon
3-1	Skim, Qt.	8700		Robert	Gordon
3-1	Choc. Milk	300		Robert	Gordon
3-7	Cream, Pt.	300		Robert	Gordon
3-7	Cream, Wh.	300		Robert	Gordon
3-16	Cottage Cheese		1	Robert	Albert

Microbiological control is a continuous effort that could be likened to some types of accounting data used in restaurants (such as a cashier's report in which close review is maintained for daily management control). This control is pursued, naturally, because of the health hazard. Also, it is known that one high count is often followed by other high counts. It is therefore imperative to take action at the first sign of trouble.

Thus, interpretation of microbiological data involves reading numbers correctly and following up on sudden increases. But, how does one know what the correct numbers should be in the first place? This is not difficult, but it does require experience since normal ranges of bacterial counts for all foods have not published in a manual. (There is a lack of standardization of microbiological analysis methods in the food industry and there is great variation in numbers. Nevertheless, limits can be set for each food.)

Setting Limits.* An upper limit is set for each food both for raw ingredients and the finished product. This upper limit is the unacceptable high number--numbers exceeding this limit may indicate unsanitary practices. These upper limits are used in the food industry as part of their food specification. (32)

Microbiological specifications for some foods have been published by the U.S. Army Natick Laboratories. Appendix B shows a specification for a raw product (eggs) and for a prepared food (shrimp creole) as examples of how microbiological specifications are written. The government is beginning to set upper limits in some food products and more limits will probably be forthcoming.

In addition to the upper limit, a normal range of bacterial numbers for each food product that is produced under good manufacturing conditions should also be established. This is usually a much lower number and is the indicator of shelf life. After this range is established by experience, deviations can be expected. But, if the counts climb consistently, it is a danger signal even though they remain within an acceptable range.

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*There are different approaches to setting limits. This is based on the approach developed by the International Commission on Microbiological Specifications for Foods. (13)

As an illustration of these two limits, the following experience of the Penticton Hospital is examined. (3) In this hospital, which uses centralized food preparation, an upper limit of 50,000 bacteria per gram was set for pre-cooked frozen food after processing. They found that this number was attainable with careful processing and it was corroborated by the experience of other processors. (Their limit was lower than the acceptable standard of 100,000 since hospital standards must be rigid). (33) This number was, in fact, expected with sauces and mixture foods that contain a variety of food products. Although their upper level was 50,000, they took immediate action when the number exceeded 25,000. Table 3 illustrates the range for their processed foods and other foods. Note the third column--"Meat, Creamed and Casserole." Most of the samples analyzed fell within 1 to 100 and 101-1,000, which could then be established as the recommended range for shelf life. Over a period, this number should be maintained and possibly improved. Thus, there is the upper unacceptable limit of 50,000 bacteria per gram and the lower normal range of 1 to 1,000 bacteria per gram, which the hospital strove to meet for creamed meat products and meat casseroles. As shown on the chart, deviations from this lower range, occurred and these alerted management that there is a problem. In column 10, "Cream Pudding and Sauces," two products tested were as high as 100,000--1 million, and one was over one million. Lab personnel determined that the cause was either

Table 3

Distribution of Total Counts

	Meat Fish Poultry	Comm Meat	Meat Crmd Cass	Veg	Veg Crmd or Cass	Milk Comm	Stch Comm	Egg and Milk Bev	Egg Cooked	Cream Pdg and Sauce	Soup and Meat Sauce	Sugar Based Sauce	Salads	Pastries Cakes Bread	* Misc	Total
0	1	1	5	6	3	0	0	0	2	5	4	3	0	0	1	31
1-100	10	7	15	13	4	1	2	1	10	15	8	1	2	4	2	95
101-1,000	7	5	11	5	6	3	1	2	3	17	7	4	2	1	3	77
1,001-10,000	11	7	3	4	1	0	2	2	1	6	0	0	3	2	0	42
10,001-100,000	3	2	4	1	0	0	0	3	0	7	0	0	3	0	0	23
100,000-1 mill	0	0	0	0	0	1	0	1	0	1	0	0	4	0	0	7
over 1 million	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Total	32	22	38	29	14	5	5	9	16	52	19	8	14	7	6	276

*Includes: Textured veg. protein - 1 sample; poultry dressing - 2 samples
soy sauce - 1 sample; oatmeal cereal - 2 samples

contaminated milk or mishandling that had occurred in the tempering of the frozen food. Followup and subsequent checking by microbiological analysis brought the product back in line.

Reasons for Microbiological Quality Control Programs

In the food industry, there are three reasons for microbiological quality control. These are listed in the order of their importance: (40)

1. To produce safe foods as food can be a carrier of pathogenic microorganisms and/or toxins produced by microorganisms.
2. To enhance the economic value of the food, i.e., by increasing sales and profit by increasing shelf-life.
3. To conform with sanitary regulations of federal or state regulations of federal or state regulatory agencies.

Safe Foods

The first reason for microbiological quality control programs is to produce safe food. Appendix C, "Certain Bacteria in Food Require Total Attention," by Kurosh Ostovar, describes food poisoning and the three most common types of food poisoning microorganisms. (29)

The record of the restaurant industry in the area of food safety has been poor. If traditional restaurant operators were to move their operations into food plants

and continue their traditional restaurant sanitary practices, the results could be disastrous. The following chart indicates a much greater incidence of food poisoning in food service establishments than in the home or in food processing plants. (8)

Table 4

Places Where Foods Were Mishandled in Such a Way That Food-borne Disease Outbreaks Resulted

Place	Number	Percent
Food Service Establishments	589	37
Homes	230	14
Food Processing Plants	104	6
Unknown or Unspecified	692	43
Total	1615	100

Some real examples of outbreaks that happened in the last few years were reported in the New York Times. In 1973, twenty-five students from five schools were hospitalized after eating contaminated egg salad sandwiches. On three flights from Lisbon, Portugal, 247 passengers became ill after eating contaminated custard. (27) In 1972, 100 elderly persons became sick and the incriminating food was chopped liver at a Yom Kippur celebration in Philadelphia. (27) In 1971, one hundred and sixteen members of a wedding party were stricken by food poisoning. Needless to say, no food establishment needs this adverse advertising, and such

outbreaks as these have actually bankrupted respectable firms. With centralized food preparation, the possibility of poisoning thousands--not merely hundreds--of people at one time now exists. But microbiological quality control can initiate a program for safe foods in a centralized food service facility.

Increase Sales and Profit by Increasing Shelf Life

The second reason for microbiological control is to extend shelf life of perishable foods. Increased shelf life can have an immense impact upon the profitability of the centralized food service. An example from the dairy industry can illustrate this point. A large dairy found that its cottage cheese was not keeping and that numerous returns were being made of the spoiled product. A food scientist was able to isolate the bacteria responsible, but he could not determine the source of contamination. Finally, someone happened to observe the night cleaning crew. One of the workmen each night swept a small puddle of water in the sanitized cheese-making vat into the drain with a sponge. The sponge was, of course, loaded with the spoilage organism. Extending shelf life using microbiological methods is a specialized skill of the food scientist.

Shelf Life. The shelf life can be defined as the amount of time a food will last without organoleptic deterioration. Shelf life has not been part of the

traditional restauranteur's vocabulary because of rapid product turnover. Waste, due to spoiled food has been, in the traditional restauranteur's opinion, due simply to poor management.

With centralized food facilities, however, shelf life" becomes an every-day term. In addition to longer holding periods for food, most deliveries from the plant are no longer made daily; the food must be safe for a longer period, and its quality must be maintained. Food vending companies have been familiar with the importance of shelf life for years because of their chilled food products. Chilled food systems are being anticipated in centralized food preparation facilities (44) as well as combination chill-freeze systems. (36) Microbiology is most important in these systems because knowledge of spoilage organisms can significantly increase the shelf life of foods. Control of the spoilage organisms occupies most of the time of dairy plant labs. The control of the spoilage organisms indirectly control the food poisoning microorganisms.

When relating microbiology and shelf life, the following principles should be noted:

1. Age and quality do not necessarily correlate.
2. The spoilage organism present in the raw ingredients and subsequent contamination may determine the shelf life of chilled food.
3. Raw ingredients may have reached the end point of their shelf life before they are used.
4. The microbial load may be hazardous to health before the flavor is affected.

5. A few degrees change of temperature may be disastrous to the shelf life of a product.

There are a number of factors that affect shelf life, but time and temperature are most important. (2) Spoilage bacteria will grow at low refrigeration temperatures, but they do need time to grow and multiply. This growth is exponential making it necessary to keep numbers low. One can say that growing time is subordinate to temperature and dependent upon it.

The following figure (Figure 1) illustrates the relationship between contamination and spoilage. (12) In all three cases the chicken is five days old, but only the chicken with the lowest contamination has not deteriorated to the point where odor and slime are obvious. This also points out that age and quality of product may not be correlated. It is time, temperature, and contamination that determine the shelf life. Another example is in the prevention of contamination after pasteurization which has led to claims for shelf life of dairy products of from six weeks to six months for such products as whipping cream, chocolate milk, and half and half. (39) Pasteurization could be used for other products than milk and a food scientist at the plant should be aware of such possibilities. Appendix D, "Recommendations for Prevention of Bacterial Food Poisoning," suggests heat treatment for salad ingredients to increase shelf life. (22)

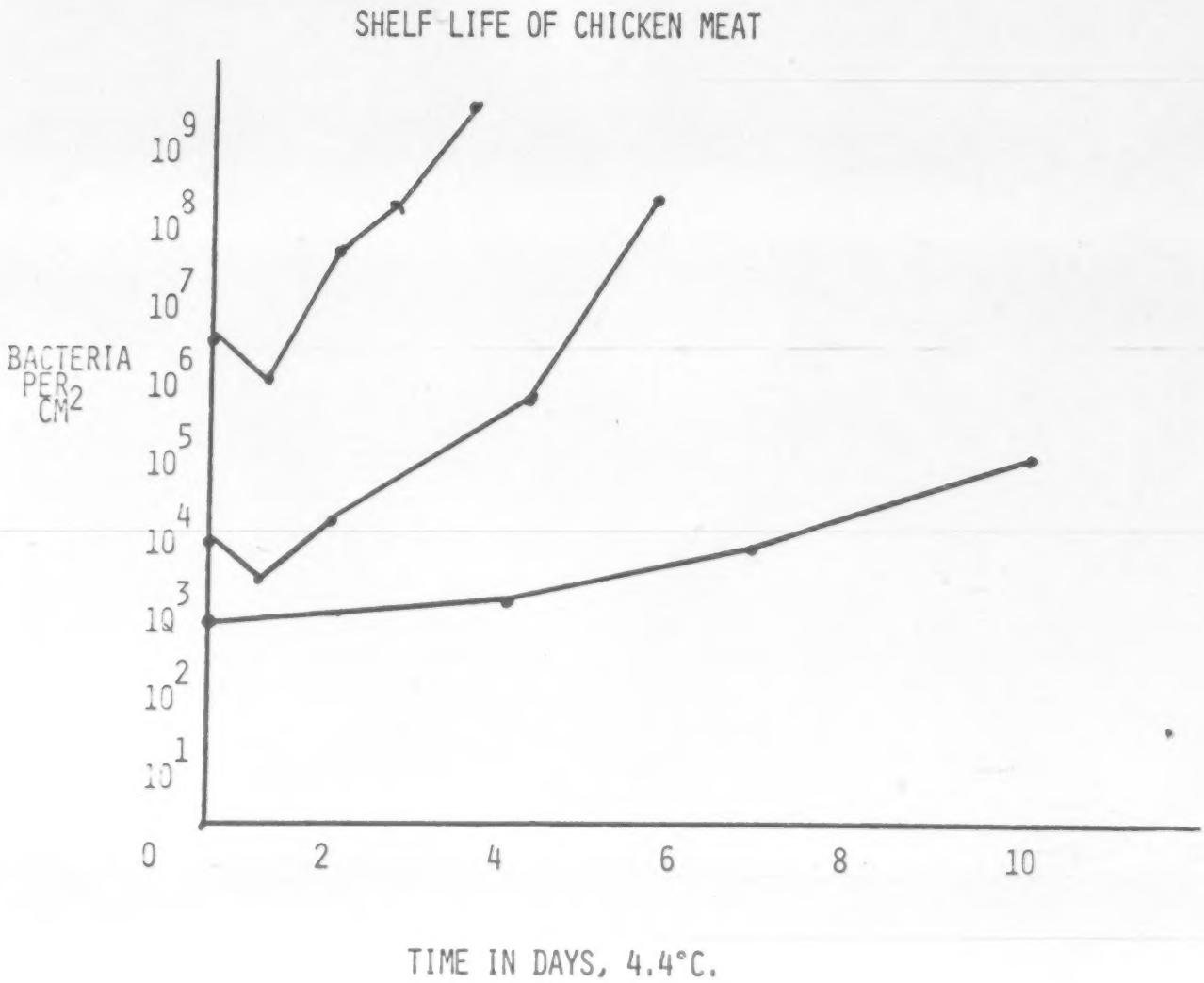


Figure 1. Effect of initial microbial load on the shelf life of chicken meat.

Food suppliers become crucial in extending shelf life. If the raw ingredients have been contaminated and/or held, the shelf life is reduced before it reaches the processing plant. A good example is frozen fish. Uneviserated fish is often held on ice on the boat for up to ten days before it reaches the freezing plant. (16) A microbiological quality control program can eliminate suppliers who consistently mishandle perishable foods.

A major problem in extending shelf life is with foods containing more than one ingredient. If the microbial load of just one component is out of line, the bacteria will become mixed with the entire product. This has been a problem with spices--ingredients that is not hazardous, in themselves, but often carry high numbers of spoilage bacteria. If the contaminated spice is added to a food that is easily spoiled, like a cream sauce, the shelf life may be affected. The following table shows counts of spices that were taken by Penticton Hospital. (3) Because of this problem some spices are being treated with ethylene oxide to sterilize them.

Packaging can affect the type of spoilage organisms that grow in foods. The danger of new types of packaging in relation to microbiology is that a package designed to control another type of spoilage (usually oxidative) could unwittingly be incorrectly stored with the false security that the package lends microbial safety. (19)

Table 5

Total Counts of Commercially Packed Spices

Spice	Anaerobes	Total Count per gram	Spice	Anaerobes	Total Count per gram
Allspice	0	over 1 million	Nutmeg	0	8,100
Bay leaf	0	0	Oregano	0	51,900
Bread crumbs	0	33	Paprika	0	617,000
Caraway seed	0	16,000	Parsley	0	765
Celery seed	0	35,000	Pepper (corns)	+	611,000
Chili powder	0	3,780	Pepper (ground)	+	over 1 million
Cinnamon	0	515	Pickling spice	0	24,250
Cloves (ground)	0	2,950	Poultry seasoning	+	42,000
Cumin seed (ground)	+	7,450	Poultry spice	+	125,000
Curry powder	0	over 1 million	Rosemary	+	41,375
Dill seed	0	7,800	Sage (ground)	+	5,215
Garlic salt	0	300	Sesame seed (toasted)	-	200
Mace	0	7,250	Sweet basil	+	over 1 million
Marjoram	0	2,400	Thyme	+	159,000

From this, one could be led to believe that microorganisms are the sole cause of food deterioration. Unfortunately, this is not true. (If it were, the food scientist's job would be much easier.) Spoilage may also be caused by such factors as oxidative or hydrolytic rancidity of fats, other action by enzymes, and chemical changes within the food. (Loss of vitamins, color change, texture change, etc.)

A quality control program that employs a food scientist helps prevent all types of spoilage of perishable foods, not just microbiological spoilage. This discussion of shelf life points out the varied areas in which the food scientist works to control spoilage. It is obvious that the greatest advantage of the microbiological quality control program is the economic advantage in the extension of shelf life of perishable foods.

Conforming with Sanitary Regulations

Unfortunately, many companies begin to use microbiological testing only because problems have arisen in which a regulatory agency is involved (15).

State regulations vary and one should refer to local officials for microbiological regulations. Under federal jurisdiction, food plants are either covered by the United States Department of Agriculture (USDA) (meat products) or by the Food and Drug Association (FDA). Meat inspectors (USDA) usually rely upon visual inspection rather than micro-

Other Advantages of Microbiological Quality Control

Food plants with a microbiological quality control program accrue other advantages because of the knowledge and expertise of the food scientist. For example, at the Marriott food plant, Fairfield Farms Kitchens, in Washington, D.C., turkey dinners were processed in November, 1974. At Christmas their restaurants sold around 30,000 units of pre-cooked frozen turkey dinners for $18.95 each. All components were cooked and frozen in the plant--whole stuffed turkeys, gravy, and cranberry sauce. Frozen cooked and stuffed turkeys are classed as a hazardous item, and it is necessary to know exactly how to handle this product to prevent the chance of food poisoning. The economic benefits are obvious: The turkey was scheduled for times of slow production in the plant and, as a take-home product, was a volume builder for the stores.

Overview of a Microbiological Quality Control Program for Centralized Food Service

While there are decided advantages of the microbiological quality control program, a poorly thought out program can be ineffective. The purpose of the following section is to discuss in a general way, the approach to microbiological control.

Microbiological Quality Control is a part of the department in a food processing plant called "Quality

Control." In a small plant the quality control department may consist of one person--typically a food scientist or chemist. In a large factory, Quality Control involves a team of specialists who report directly to top management. (23)

The Quality Control Department's functions are complex and varied. But it is concerned primarily with two areas: (1) control of raw materials--testing for hazardous chemicals and microbial hazards, specifications for purchasing, and inspection of incoming foods and supplies; and (2) process control--sanitation and microbiological programs in the plant, scheduling production, packaging problems, training line personnel, production and equipment efficiency, and other functions depending upon the organization of the factory. (23)

In a centralized food preparation facility, quality control must be extended to the distribution of the food and to the retail outlet or sales unit because responsibility does not end after the food has been processed.

For the microbiological work there are two choices: (1) an in-plant laboratory, or (2) an outside laboratory. The plant with its own laboratory staffed with a food scientist tends to have a better quality control program than the plant that has its microbiological testing done by an outside laboratory. Continuous monitoring and upgrading of the sanitation program is much easier to accomplish when the quality control work is being done in the plant.

In addition, the quality control personnel in the plant are closely associated with the needs of the food organization and are able to innovate new methods as they are needed. Also, trained lab personnel can complement lab data with physical inspection of the processing facilities.

The psychological effect of having continuous control is significant. The personnel from the quality control department, taking samples and checking upon critical control points and continually monitoring sanitation, has a definite effect upon microbiological quality. For example, the following data is taken from a Pennsylvania plant laboratory record:

Table 6

Pennsylvania Plant - Holding Quality Test
(Homogenized Milk)

Date	Product	SPC
11/14	Bulk	3200
11/14	P.L.*	2400
11/14	Pint	3300
11/19	1/2 Gal.	24000
11/21	Pint	300
11/27	Quart	13000
11/29	P.L.	540
11/30	Bulk	300
11/30	P.L.	300
12/3	Quart	300
12/5	Bulk	300
12/5	P.L.	300

*Processing Line

The laboratory supervisor was away from the plant for a two-week period (11/14 to 11/30). As soon as the supervisor left, there was a sudden increase in bacterial levels (not to dangerous levels, however, as the state maximum level is 20,000 organisms per ml.). When the laboratory supervisor returned, the numbers immediately dropped (Laboratory personnel remarked that they could predict the outcome of each trip out of town).

In staffing a plant laboratory, an experienced food scientist is the best choice rather than a microbiologist. The food scientist has an overall knowledge of food processing that a general microbiologist does not have.

Outside Laboratory. A small plant that cannot justify having its own laboratory because the quality control department does not have the time or resources to perform the microbiological tests, may resort to outside laboratories.

In choosing an outside laboratory, state and federally approved milk laboratories are recommended. (4) These laboratories perform standardized tests and their results maintain consistency (as discussed in the previous section). Also, they are involved in microbiological analysis of food in addition to milk testing. Actually, milk testing is only a small part of their workload. These laboratories are listed in Public Health Service Publication No. 1925 entitled "Milk Laboratories Approved by Federal and State Agencies." (4) It is available at no charge from the Public Health Service, Food and Drug Administration, Office

of Science, Division of Microbiology, Cincinnati, Ohio 45226.

Whether an in-plant or outside laboratory is chosen for the microbiological work, the microbiological quality control program must be carefully planned. In centralized food preparation, food safety does not end when the food is processed. Rather it continues through distribution channels and to the point of consumption. Therefore, microbiological testing is established at "critical points" throughout the food system. Testing is made on raw ingredients, during processing, in storage, during transportation and at the retail outlet. The food scientist or the consulting laboratory can pinpoint the critical points for testing so that the program will not become cumbersome and overly expensive, and yet it can still provide enough information to result in safe foods and extended shelf life.

There are three types of laboratories listed in this manual: (1) central and official laboratories, (2) commercial laboratories, and (3) industry laboratories. The central and official laboratories are not involved with this type of testing. The "commercial" laboratories actively test food products and are the best choice. If there are no commercial laboratories available, industry laboratories might do food work; but they are usually labs for milk plants and are too overloaded to do food work.

When a quality control system is being initiated, an outside laboratory may help plan the microbiological control

system. This consulting service may also be available from the food science department in universities.

Areas for Microbiological Control in Centralized Preparation

Raw Ingredient. "Control at source is the way to reduce microbial problems. Analysis of final product is only one tool." (13) If raw ingredients are purchased in a large enough volume, microbiological specifications can be employed. This is sometimes necessary with such hazardous foods as frozen eggs, or in the feeding of children or geriatric patients. This is one area where test results might need to be known before the ingredients were used. With raw ingredients, the skill of the food microbiologist is necessary because the type of contamination varies with the product. (For example, yeast and mold tests might be run on flours and flour mixes.) Incoming food should be tested systematically. As important as the testing program would be a program set up to periodically inspect the facilities of the supplier for sanitation. Naturally, a potential supplier would have to be inspected for cleanliness and good manufacturing practices. A raw materials quality control system where a great variety of foods were coming in, would place the emphasis upon hazardous raw materials. (21)

Processing. High numbers of microorganisms are usually due to (9)

1. Poor personal hygiene of the food handlers,
2. Ineffective cleaning and sanitation program,
3. Improper holding temperatures during processing and storage, and
4. Extended time period for food product during processing.

A microbiological quality control program for the processing procedure should check both equipment sanitation and personnel sanitation. Equipment sanitation is tested by swab tests or agar applied directly to the surface of the machinery. Personnel sanitation is monitored by coliform tests which will determine contamination after heat treatment. It is best to set up a definite schedule of testing focusing on the critical points in processing. Every process should be analyzed for its critical control points, and it may be necessary to have specialized assistance in setting up this quality control program.

Storage. If perishable foods are refrigerated or frozen on premise for a period of time before being shipped to the restaurant, sampling can be made before and after the storage period to determine if storage temperatures have fluctuated. Of course, storage areas should be inspected for cleanliness.

Transportation. If you stand behind a restaurant and watch food deliveries being made, you will notice vans, autos, and open trucks, but very few refrigerated vehicles (except dairy trucks). For commissaries where the object is to decrease microbial load, refrigerated trucks are a

necessity. But a refrigerated truck cannot be used to cool down a truck load of warm food. They are designed to pick up cooled food and keep it cool. (35) Microbiological tests can be made on foods loaded onto trucks, especially if they are on the road a long time. Route trucks of vending operations have exposed sandwiches to temperatures of up to 120° F. for up to two hours. (26) Bacterial populations multiply very rapidly on a hot humid day. Occasionally, too, a trucker will turn off the refrigerator unit because the humming annoys him. (35) This is to point out that systematic approach to microbiological quality control does not stop at the processing plant.

The Retail Outlet

Perhaps the most critical point in the food system is the retail outlet. The employees tend to be traditional restaurant workers who prefer traditional methods of handling food. But the quality control program must be extended to this part of the food system. Therefore, it is essential that management in the restaurant units have an understanding of the value of the microbiological testing program. To determine growth of microorganisms, the food could well be sampled (1) when it is received, (2) after storage, (3) when it is placed on the steam table, and (4) after the longest holding periods on the steam table. In addition, the process of sampling in itself will most likely prove beneficial in maintaining sanitation levels.

Overall Control

Each food product should be analyzed during its journey from raw ingredient to consumption. The following chart (Figure 2) illustrates the control process for a cooked meat like roast beef. The chart has been adapted from page 38 of the "Fort Lewis Experiment Application of Food Technology and Engineering to Central Preparation." by D. B. Rowley et al. (44) The critical moments have been pinpointed and a testing program set up at specific points during processing. Again, the microbiological quality control program does not end when the food is processed but continues throughout the food system.

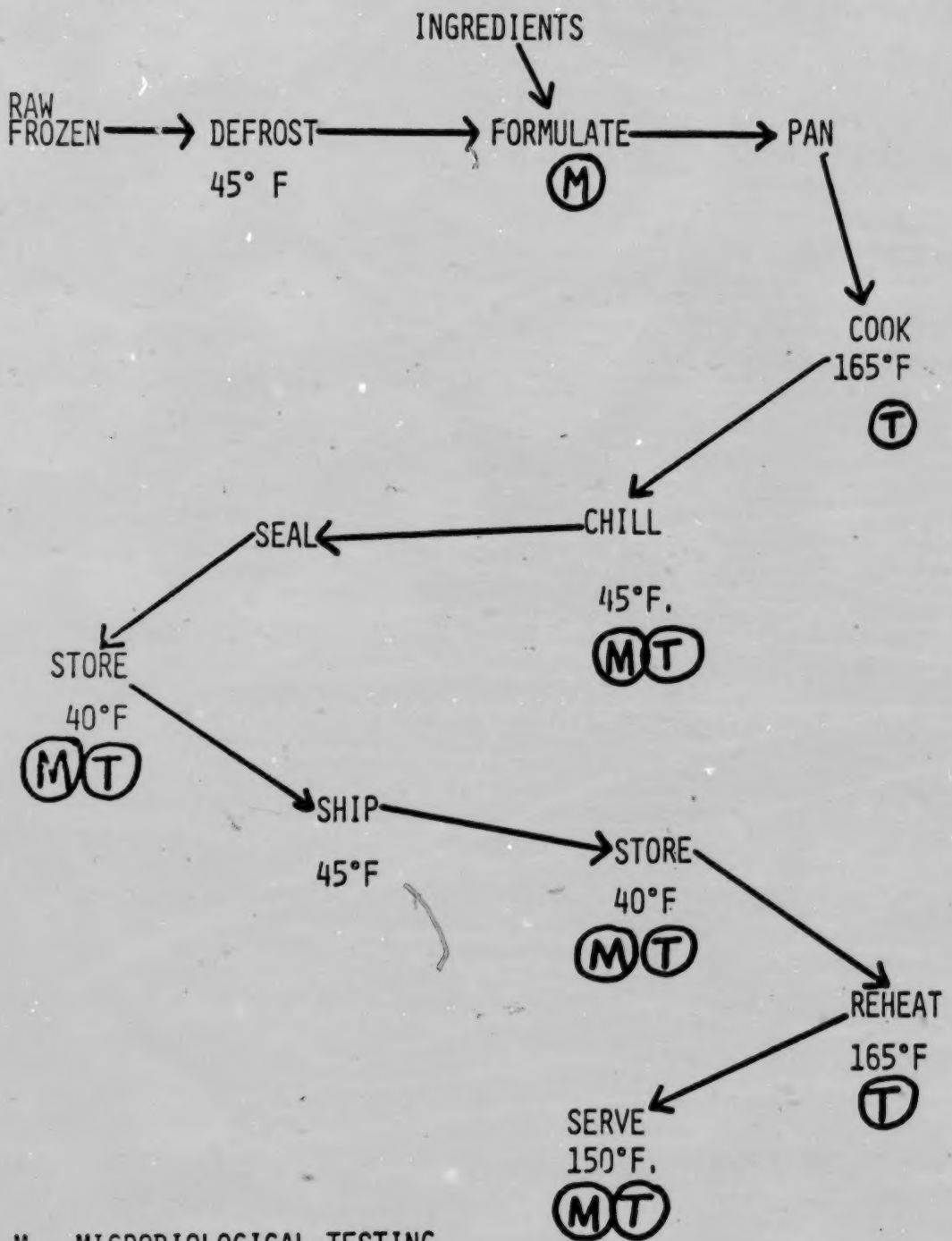
Summary

More and more food service establishments are centralizing their food preparation but using traditional employees both in production and in management. The food service industry has had a poor record in food safety, and there would be an enormous danger to the public if traditional methods of sanitation were continued. (The numbers that could be made ill by one outbreak could range in the thousands.) It is therefore necessary to adopt a new concept of sanitation--microbiological quality control.

Microbiological quality control is a part of the Quality Control Department within a food factory. The three reasons for microbiological quality control are

MEAT

PROCESS CONTROL CHART



M - MICROBIOLOGICAL TESTING

T - TEMPERATURE CONTROL

FIGURE 2

(1) public safety, (2) increased sales and profits, and (3) conformity with federal and state regulations. Microbiological quality control functions by using microbiological analytical testing throughout the food system--from the raw ingredient to the retail outlet.

The test results provide feedback to management which can result in safe food, an increase in shelf life, and an increase in the quality of the food. Management, in turn, must be able to interpret the microbiological tests correctly.

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Appendix A

Numbers of Bacteria in Food

How much bacteria is there in food? Consumer groups often become upset because of the larger numbers of bacteria in some foods. The fact is that in raw foods bacteria occur naturally. Only by sterilization are all bacteria destroyed. The foods coming from centralized food processors will not be sterile. It is normal for foods to have bacterial numbers of thousands per gram. A gram of food is small indeed--there are 454 grams in a pound. The men who went out in space during the Skylab experiments had an unusual food problem. They had no way of resupplying their food if it became spoiled. The space agency, therefore, took extreme precautions to provide foods with the lowest bacterial counts. The following are a few of the counts of food they sent into space:

Product	APC	Coliform
Scrambled Egg	1,020	Pos.
Mashed Potato	8,960	Neg.
Vanilla Ice Cream	450	Neg.
Filet Mignon	6,400	Neg.
Prime Rib of Beef	160	Neg.
Grape Drink	20	---
Black Coffee	1,100	---
Hard Candy	20	Neg.
Peanut Butter	4,380	---

This is to point out that with the best of foods, there are still many bacteria.

One could make the point that a low count food (a food with few bacteria per gram) could contain only pathogens and still be harmful. But, rarely does it work this way when there is a good testing program and good manufacturing practices are followed for the food product. The reason is that the food will not be likely to be contaminated if the plant sanitation program is constantly monitored and if the suppliers are checked as a part of the monitoring program for their role in supplying clean foods to the plant and the monitoring program is extended to the retail outlet.

Food plants keep microbiological records confidential. This is because the general public could generate unfavorable, misleading publicity from the best of operations: The "Did you know that your peanut butter had thousands of germs in it" type of thing. Even with management this is a problem. For example, in one plant, management was concerned with high coliform counts in raw salads compared with other foods. They were not aware that this occurs naturally.

Appendix B

Samples of Microbiological Specification: from Microbiological Requirements and Methodology for Food in Military and Federal Specifications, Technical Report 73-33-FL, U.S. Army Natick Laboratories, Natick, Mass., Ed. by Edmund M. Powers

C-E-230C

November 16, 1970
Superseding

Int. Fed. Spec. C-E-00230B (AGR-C&MS)
August 28, 1962 and
Fed. Spec. C-E-230A

Federal Specification

Egg and Egg Products, Frozen

This specification was approved by the Commissioner, Federal Supply Service, General Services Administration, for use of all Federal agencies.

1. Scope and Classification

1.1 Scope. This specification covers frozen whole eggs, egg white, egg yolks, sugar yolks, and salt yolks.

1.2 Classification.

1.2.1 Types, kinds, and classes. The product shall be of the following types, kinds, and classes, as specified (see 6.1):

Types:

I - The storage time prior to delivery shall not exceed 365 days from date of production.

II - Shall be produced subsequent to award of contract.

Kinds:

a - Frozen whole egg, table grade (type II, class 1 only).

b - Frozen whole eggs.

c - Frozen egg white.

d - Frozen egg yolk.

e - Frozen sugared yolk.

f - Frozen salted yolk.

Classes:

1 - Shall meet the requirements of 3.3.

2 - Shall be wholesome and shall possess a clean and bland odor as determined by organoleptic examination (not applicable for Military procurement).

3.3 Finished product.

3.3.2 Microbiological requirements.

Item	Test	Frozen table grade whole eggs	Frozen whole eggs	Frozen white	Frozen yolk	Frozen sugar yolk	Frozen salt yolk
5	Standard plate count per gram	≤20,000	≤50,000	≤50,000	≤50,000	≤50,000	≤50,000
6	Yeast and mold count per gram	≤50	≤50	≤50	≤50	≤50	≤50
7	Salmonellaw test/	Neg	Neg	Neg	Neg	Neg	Neg

1/ Samples for microbiological examination shall arrive at the Government Laboratory in a solidly frozen condition and held in such condition until tested.

4.2.9 Sampling procedure and acceptance criteria for testing of finished products. The finished product shall be tested for total plate count, yeast and mold count and Salmonella as specified in 3.3.2. Procedures for testing shall be in accordance with 4.3.2. Test requirements for Salmonella, total plate count and yeast and mold count shall be on a unit basis. The sample unit for Salmonella, total plate count and yeast and mold count shall be an 8 ounce sample derived aseptically from 1 primary container. Lot size shall be expressed in terms of the sample unit. The sample size shall be the number of cans indicated by inspection level S-1. Samples of liquid egg product(s) sent to any Government laboratory for bacteriological or analytical testing shall be frozen solid prior to shipment and shall be in a solid frozen state when received at the laboratory. Salmonella shall be reported on a pass or fail basis. Microbiological counts shall be reported in accordance with Recommended Methods for the Microbiological Examination of Foods of the American Public Health Assocaition. Non-conformance to one or more test requirements shall be cause for rejection of the lot.

4.3.2 Microbiological examination. The total plate count and the yeast and mold count shall be determined in accordance with the following methods from Recommended Methods for the Microbiological Examination of Foods, Chapter: Egg and Egg Products, Section: Frozen Eggs:

Item	Test	Method
1	Total count	Total count
2	Yeast and mold count	Yeast and mold count

4.3.2.1 Salmonella shall be determined in accordance with the USDA procedure as outlined in USDA Laboratory Methods for Egg Products, Consumer and Marketing Service.

LP/P DES 37-30

22 July 1970

(GL)

Limited Production Purchase Description

for

Shrimp Creole, Cooked, Frozen

The use of this document is restricted to the specific purpose for which it was originally furnished.

1. Scope

1.1 This purchase description covers requirements for prepared shrimp creole in aluminum trays used by the Armed Forces as an item of general issue in kitchens where freezer facilities are available.

3.6 Finished product

3.6.2 Microbiological requirement.

Standard plate count	100,000 per gram
Coliforms	100 per gram
E. coli	Neg by test
Salmonella	Neg by test

4.5.4 Microbiological examination. General procedures and methods shall be in accordance with Recommended Methods for the Microbiological Examination of Foods of the American Public Health Association.

Appendix C

Certain Bacteria in Food Require Total Attention

by

Kurosh Ostovar, Ph.D.

In recent years, the consuming public has become more aware of the quality of food products and rightfully has raised many questions about their safety and standards.* Through various media, people have been exposed to reports such as botulinum problems of certain canned foods, as well as Salmonella and staphylococci contamination of raw and processed foods. The newest recognized form of food-borne illness is vibrio parahaemolyticus caused by contaminated seafoods. However, these reports by no means indicate that our foods are microbiologically speaking, unsafe or that all microorganisms are "harmful." In fact, if it were not for certain types of these microscopic creatures, the consumer would not be able to enjoy many wines, cheeses, yogurt, sour cream, buttermilk, or other fermented food items.

Foodborne disease is synonymous with food poisoning and is defined as "disease caused by ingestion of a pathogenic organism or noxious agent in food or water which would affect two or more persons." It is divided into two general types:

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*This article is reprinted from Science in Agriculture, XXI, No. 1 (Fall, 1973).

(a) foodborne infection caused by ingestion of certain pathogenic microorganisms, and (b) foodborne intoxication resulting from consumption of food containing toxin produced by certain organisms.

The three most common types of food poisoning and the organisms involved are

(a) Staphylococcus foodborne intoxication: The organism involved is referred to as Staphylococcus aureus and is found in the throat, nose, and skin of man and certain animals. It is capable of producing at least four highly heat-resistant types of toxins. A wide variety of food items such as meat and meat products, poultry and poultry products, and some baked goods are commonly involved in this foodborne intoxication. Symptoms associated with this type of food poisoning will usually appear from 2 to 8 hours after consumption of the contaminated food and are characterized by vomiting, diarrhea, headaches, and occasional chills which can last from 2 to 3 days depending upon the initial dosage of the toxin and general health of the person involved.

(b) Clostridium perfringens food poisoning: Unlike staphylococci, this is a spore-forming organism which grows best in the absence of oxygen. The organism is usually found in soil, the intestinal tracts of humans and animals, and sewage. Such an

organism is destroyed by thorough cooking. But heat-resistant spores can survive and eventually germinate after the food has been cooled and stored at room temperature. The foods usually involved in this type of poisoning are cold meat and meat products, various types of gravies, and cold poultry and poultry products. Symptoms of the illness occur within 12 to 24 hours after digestion of contaminated food and are characterized by vomiting, diarrhea, abdominal pains, and a fever that can last from 24 to 48 hours depending upon the initial dosage and physical condition of the patient.

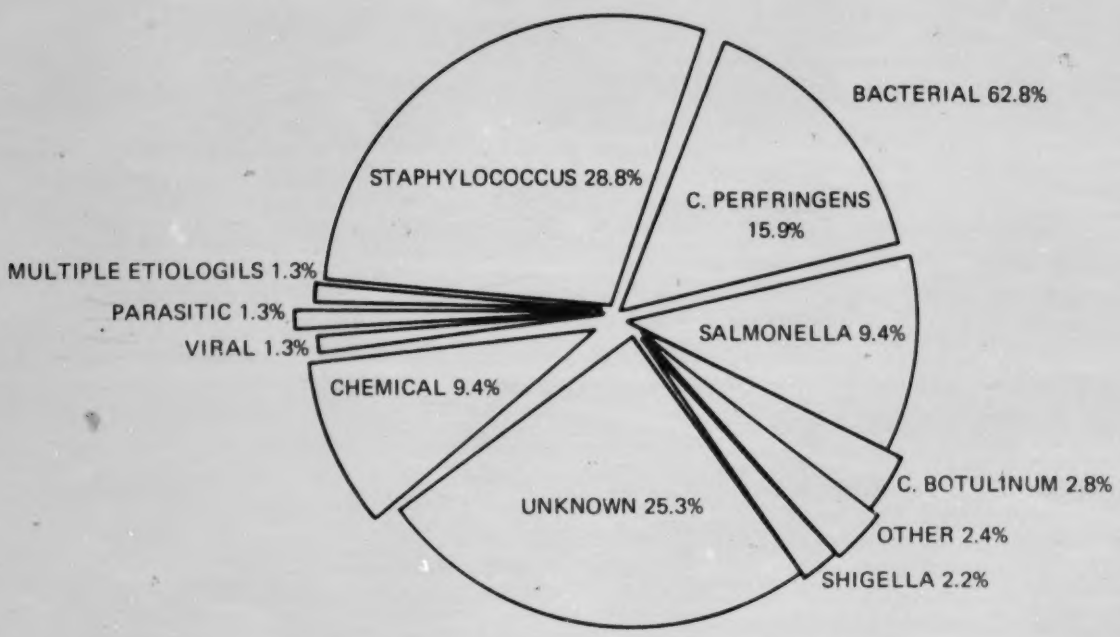
(c) Salmonella foodborne infection: There are approximately 1300 strains of this organism which can be found almost everywhere. Primarily, however, they are found in animal feces. Unlike staphylococci, Salmonella do not produce toxins. High numbers of vegetative cells must be ingested before the typical symptoms can occur. The illness is characterized by severe gastrointestinal discomfort, diarrhea, vomiting, and fever. The symptoms usually appear from 18 to 24 hours after ingestion of highly contaminated food. Commonly involved in Salmonella foodborne infection are poultry and poultry products, and certain dairy products.

Food poisoning outbreaks have been better recognized in recent years mainly due to the improved surveillance and

reporting system. In 1971 a total of 320 outbreaks involving 13,453 individuals were reported in this country. Foodborne disease outbreaks of bacteriological origin accounted for 62.8 percent while the chemical agents accounted for 9.4 percent of the total reported outbreaks. (See Figure C-1.) It is interesting to note that 25.3 percent of the outbreaks were attributed to unknown causes. Staphylococcus foodborne intoxication contributed to 28.8 percent of the outbreaks while 15.9 and 9.4 percent of the outbreaks were caused by Clostridium perfringens and Salmonella, respectively.

Figure C-1

FOODBORNE DISEASE OUTBREAKS, CONFIRMED AND UNCONFIRMED, IN THE UNITED STATES 1971.



Appendix D

Recommendations for Prevention of Bacterial Food Poisoning

by

Garden State Laboratories, Inc., Irvington, N. J.

After visiting lavatory wash hands well; reduce food handling by hands to a minimum; avoid touching hands to nose, face, or clothes; make use of forks, spoons, etc., for preparing and serving foods. Persons with boils, sore throats, colds, open sores, must not handle food.

Non-acid foods: Puddings (choc., vanilla, etc.); custards; pumpkin pie; bread pudding; cream filled pies (except lemon); cream-filled cakes--eclairs, charlotte russes; potato, chicken, salmon, shrimp and pork salads; hash, etc., which may be freely handled during preparing and served without subsequent cooking, OR only partial cooking, should be prepared in a sanitary manner shortly before serving, preferably within two hours. Refrigerate in a shallow layer at below 40° F. Keep all foods at below 40° F. or above 140° F. to prevent bacterial growth and toxin formation.

Many of the toxins (poisons) formed by food poisoning bacteria are not destroyed by heat, once they are formed; however, the bacteria may be killed, hence any heat treatment of food should be performed before a long incubation period elapses.

Sanitary Preparation of Potentially Hazardous Foods--Salads

(10 Steps in Making a Low Bacterial Count Product.)

1. Refrigerate all cooked salad ingredients except seasonings and spices overnight or chill to 45° F. or lower before use.
2. Purchase a sanitizing solution or prepare one by mixing two ounces of bleach to a gallon of cold water. This solution is effective for about two hours. Prepare a fresh solution if further sanitization is needed.
3. Clean work surfaces, utensils and equipment (pots, pans, spoons, spatulas, etc.,) with soap and hot water, rinse with clean water, and then give a final rinse with sanitization solution. Stainless steel utensils and equipment are preferred in preparation of these foods.
4. Clean hands, fingernails and arms thoroughly with a germicidal soap and hot water and dry with single use paper towels, or use disposable plastic gloves.
5. Individuals preparing salads are not to perform other tasks such as handling raw chickens, raw meats, etc., while engaged in salad preparation.
6. Clean and sanitize tops of cans and jars before opening. Once opened use up all of content within one day. Do not put unclean spoons, etc., in opened jars or cans.
7. Make salads fresh each morning, do not mix old salads with fresh.

8. Place washed, diced celery, lettuce, and carrots, including pre-cut packaged celery in a strainer and immerse in boiling water for 30 seconds and then rinse immediately in cold water and chill to 45° F. or less.
9. Use clean and sanitized utensils in mixing and handling of foods. See #4.
10. Refrigerate final salad product immediately in shallow pan.

Additional Instructions Relative to Specific Salads--Shrimp, Lobster, Egg Salads, Etc.

Shrimp, Lobster Salad, etc.

Immerse shrimp or lobster meat in boiling water for 30 seconds and then rinse in cold water, chill to 45° F., or less, before adding to salad.

Egg Salad;
After removing shell, immerse hard boiled eggs in boiling water 30 seconds and then chill 45° F., or less before adding to salad.

Chicken Salad;
After removal from bones, immerse chicken meat in boiling water or boiling stock for 30 seconds and then chill to 45° F., or less before adding to salad.

Ham Salad;
Immerse diced ham in boiling water or stock for 30 seconds and then chill to 45° F., or less before adding to salad.

Pepper, oregano and other spices and seasonings should be sterilized by dry heat before use. Oven or oven type toaster can be used.

Persons with infected cuts or sores on hands are not to prepare salads.

PROBLEMS WITH REGULATIONS IN THE FOOD PROCESSING AND DELIVERY INDUSTRIES PENNSYLVANIA: A CASE STUDY

by

Manfred Kroger, Ph.D.

PROBLEMS WITH REGULATIONS IN THE FOOD PROCESSING AND DELIVERY INDUSTRIES PENNSYLVANIA: A CASE STUDY

Introduction

The difference between a food processing plant and an eating establishment is easily discerned.* There is obviously a sharp line of demarcation between the two, and food regulations governing these two areas ought to have evolved separately. But this is not so, and consequently some confusion exists in keeping these areas of activity apart. Often two basic sets of regulations can be found: the one addressing itself to food manufacturers and distributors and the other one to food service operators, namely, those who present food to the public for immediate consumption. In Pennsylvania, these two sets of regulations are enforced by different state government agencies: food processors come under the jurisdiction of the Bureau of Foods and Chemistry, Department of Agriculture; while eating establishments are regulated by the Division of Food Protection, Department of Environmental Resources (formerly in the Department of Health). Other states have similar split arrangements.

The result of this evolution is unfortunate, since this split of relatively similar regulations for two very similar industries with a common commodity and common problems, has resulted in duplication of

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*The author gratefully acknowledges the information and suggestions provided by Glorio J. Patsy, Chief, Division of Food Control, Pa. Dept. of Agriculture; and W. Joel Simpson, Chief, Division of Food Protection, Pa. Dept. of Environmental Resources. But of course the author, alone, is responsible for the content of this paper.

regulatory effort, confusion among the regulated and the public, and often a rivalry between regulatory agencies that could conceivably be used for political or unscrupulous ends. Consolidation of the two efforts might prove to be an effective means of bringing about more effective food regulatory enforcement and more efficient public health protection.

When a food processing plant decides also to operate a restaurant business on its premises it becomes the subject to both food regulations and food service regulations.

When a food service operation, like a restaurant or commissary begins to produce food for shipment and consumption elsewhere, it also assumes the function of a bona fide food processor (in the legal or traditional sense) and, therefore, must also become subject to a new set of regulations--namely, those that govern the food processing industry.

When a newcomer attempts to enter either the food processing or the food delivery industry, this uninitiated party will be confronted by such a plethora of laws, regulations, and guidelines that it is a wonder that entries into the field are made at all. It is indeed ironic that despite the many legal requirements for an entrepreneur there is a remarkable lack of official assistance through the maze of regulations.

A case in point might be the attempt to obtain approval for a set of plans for a food processing operation, or even help to draw up such plans. A number of operators literally have had to walk their blueprints through several offices--and to obtain only verbal assurance that the proposed set-ups would meet legal requirements. Obviously, there is no readily identifiable government source of information or authority to

help a food service businessman have his operation conform from the very beginning with all building, sanitary, safety, and other requirements.

Similar complaints have also been voiced by those who intend to convert an old plant into a new one. It seems that a wrong start is actually encouraged by regulatory officials who then go about their usual task of finding out and rectifying what was started wrong in the first place.

The Federal Food and Drug Administration has jurisdiction over the food processing industry, commissaries, restaurants, food factories, and all food service operations when their products are shipped in interstate commerce. But FDA has not enforced its regulations actively in the food service area and has acted only in an advisory capacity for state and local regulatory officials who have primary jurisdiction over such food operations. As these operations grow in size and enlarge their geographical distribution areas, FDA will undoubtedly look at them as true food processors and devote more attention to them. Such expanded activities by FDA would, of course, require higher levels of funding for that federal agency. The area of advising the public and business people on regulatory requirements from the very beginning of an operation seems also to be in need of improvement.

At present, the task of inspection, possibly education, and enforcement of regulation of food service establishments lies with state agencies. Local boards of health may also be involved in certain areas. When a food company or system begins to ship products across state lines, it will theoretically become subject to federal inspection and regulations also. As pointed out, FDA will not necessarily expand its activities to cover that producer, but rely on state officials to

continue their efforts (if not increase them). It is often not clear which state agency is responsible for a certain case. Duplication of inspection effort may be the result, with the concomitant increased expense to taxpayers and complaints by the management of the inspected establishments. On the other hand, complete negligence of inspection could also result if regulatory agencies were confused themselves about their areas of activity. The usual approach is to have memoranda of agreement signed and adhered to by agencies whenever such cases of confusion become evident.

A model memorandum might be the one, beginning July 1, 1975, between the Pennsylvania Secretaries of Agriculture and Environmental Resources to clarify responsibilities between the two departments for inspection of food service and food processing establishments. The agreement will enable the two departments to resolve problems arising from overlapping functions. The agreement covers the conduct of inspections only; enforcement remains with the department having statutory authority. Overall, such an agreement is expected to assure the best possible comprehensive food protection for the public, to maximize the use of the resources of the agencies concerned, to avoid gaps in food surveillance coverage, and to initiate the development of broader cooperative efforts.

Eating Establishments

In Pennsylvania, the regulatory duties are being discharged by the Division of Food Protection (in the Bureau of Community Environmental Control) of the Department of Environmental Resources (formerly in the Department of Health), Commonwealth of Pennsylvania, Harrisburg (P.O.

Box 2063, PA 17120). The particular regulatory document is

Title 25. Rules and Regulations
Part I. Department of Environmental Resources
Subpart D. Environmental Health and Safety
Article I. Food Protection
Chapter 151. Food Establishments

The regulation has a number of provisions. The following listing serves as an illustration:

Subchapter A. General Provisions
Paragraph 151.1 Definitions
151.2 Purpose
151.3 License requirement

Subchapter B. Public Eating and Drinking Places
Food Supplies (general, milk products, shellstock and shellfish, examination of food)

Food Protection and Storage (general, poisonous and toxic materials, cold storage facilities, frozen food)

Preparation of Certain Foods (stuffed meats and poultry, custards and cream fillings)

Health and Disease Control for Employees (employees with diseases, control of infectious employees, cleanliness)

Design and Maintenance of Equipment and Utensils (sanitary design and installation, accessibility for cleaning, single-service articles)

Cleaning and Sanitizing of Equipment and Utensils (general, manual dishwashing, machine dishwashing, lack of adequate facilities, utensils for frozen desserts and drink)

Sanitary Facilities and Controls (water supply, ice, sewage disposal, plumbing, toilet facilities, hand-washing facilities, garbage and refuse disposal, insect and rodent control)

Care of Other Facilities and Operations (floors, walls and ceilings, floor drains, surface of exterior areas, lighting, ventilation, dressing rooms and lockers, general cleanliness)

Plan Review (review by licensor)

Subchapter C. Temporary Eating and Drinking Places

Subchapter D. Retail Food Establishments

The Pennsylvania Department of Environmental Resources has jurisdiction over the following categories of food service establishments:

Restaurants
Automats
Cafes
Cafeterias
Coffee Shops
Diners
Sandwich Shops
Sandwich Preparation Places
Clubs
Organizations
Hamburger Stands
Hot Dog Stands
Lunch Bars
Lunch Counters
Lunch Rooms
Luncheonettes
Short Order Restaurants
Tea Rooms
School Food Service Areas
College Food Services
Church Food Services
Oyster and Clam Bars
Fish Fry Places
Refreshment Stands
Soda Fountains
Carry-Out Restaurants
Fast Food Places
Caterers
Shellfish Plants (if not in food stores)
Drive-in Restaurants
Pizzerias
Convenience Food Preparation Places
Catering Kitchens
Mobile Vending Vehicle Supply Commissaries
Mobile Food Vending Vehicles
Food Vending Machine Commissaries
Delicatessens (except in grocery stores)
Food Vending Machines
Interstate and Intrastate Carrier Food Services
Temporary Food Service Facilities
Dairy Bars
Ice Cream Stands
Taverns
Grills
Cocktail Bars
Night Clubs
Hotel and Temporary Residences
Migrant Camp Kitchens
Ice Manufacturing Places
Industrial Food Service Facilities
Institutional Food Services
Hospital and Nursing Food Services
Baby Formula Preparation
Fairs
Bakeries in Restaurants
Bottled Water Plants (if not in food dairies)

In Pennsylvania, there are also five county Boards of Health (Allegheny, Erie, Bucks, Philadelphia, Chester) which have responsibility for eating establishments. Their regulations may or may not be more

stringent than those of the Department of Environmental Resources. These five Boards of Health are under the jurisdiction of the Pennsylvania Department of Health. The confusion with regard to the regulation of eating establishments becomes therefore evident. In general, the Division of Food Protection, Department of Environmental Resources, does not operate where there is a county Board of Health. The Allegheny County Board of Health is said to be one of the few in the country requiring a quality or inspection grade (A, B or C) to be displayed by the eating establishments it controls.

Food Processors

The Pennsylvania Department of Agriculture has been empowered (Section 1705 of the Administrative Code of 1929, as amended):

> (a) To enforce the laws of the Commonwealth relating to the production, manufacture, transportation and sale of foods used for man, as well as every article entering into and intended for use as an ingredient in the preparation of foods for man;
>
> (b) For the purpose of enforcing such laws, from time to time, to purchase from wholesale or retail dealers samples of any food or drink, and have the same analyzed or examined, and prosecute the sale of adulterated, misbranded, or deleterious foods or drink;
>
> (c) To examine all cold storage warehouses, within the meaning of the laws of this Commonwealth, to ascertain whether they are kept in a sanitary condition, the wholesomeness of the food therein, and the time within which foods shall have been so kept;
>
> (d) To make such rules and regulations, including the adoption of definitions and standards, as shall be

necessary for the enforcement of the laws of this Commonwealth relating to oleomargarine, food, drink and cold storage warehouses;

(e) For the purpose of enforcing such laws, to enter into any place where food is produced, manufactured, sold or offered for sale, or kept, and to seize all articles of food produced, manufactured, sold, or offered for sale, or kept in violation of such laws. (Amended April 8, 1937, P.L. 274).

Section 1705 of the Administrative Code defines the responsibilities of the Bureau of Foods and Chemistry in the Department of Agriculture. The basic food law and "bible," however, is the General Food Law and Code, Chapter 45, Title 7. (A summary of all the laws administered by this state agency is reprinted in the Appendix.) But meat, meat products and poultry, are regulated by the state's Bureau of Animal Industry:

Meat Hygiene Laws
(Act of May 28, 1915, P.L. 587, as amended)

An act to protect the public health by regulating and licensing the manufacture, preparation, handling, storage, sale, transportation, and possession of meat, meat-food products and poultry; and prescribing the powers and duties of the Department of Agriculture.

Department of Agriculture Rules and Regulations:

Chapter LXI Meat Hygiene Service Regulations

Depending on the amount of flour used by a food processor, commissary or any other operation, an establishment may be labeled "licensed bakery" or "unlicensed bakery" by the Bureau of Foods and Chemistry (Pa. Dept. of Agriculture) and become subject to inspection.

The Pennsylvania Department of Agriculture (Bureau of Foods and Chemistry) now has jurisdiction over the following categories of food

establishments:

Candy Plants
Frozen Food Plants
Food Warehouses (packaged)
Fruit and Vegetable Brokers
Frozen Food Warehouses
Canning Factories
Sugar Refineries
Liquid Sugar (Syrup) Plants
Wineries and Cider Mills
Delicatessens in grocery stores
Soft Drink Bottling Plants
Restaurants, where baking is the primary function (Dunkin Donuts)
Other Food Processors
Nut Roasting and Packaging
Spice and Condiment Plants
Potato and Vegetable Processing and Packaging
Food Stores (Grocery, Supermarkets)
Packaged Meat Processors
Baby Food Manufacturing
Cream Filling Manufacturing
All Wholesale Bakeries
Convenience Food Plants
Smoked Fish Plants

NOTE: The many fairs, carnivals, circuses, festivals, and similar temporary affairs, occurring regularly throughout the Commonwealth, often involve facilities under the jurisdiction of both agencies. To minimize confusion and the expenditure of manpower, representatives of both agencies shall meet prior to the opening date of each fair, carnival, etc., to predetermine the inspectional jurisdiction over the various facilities.

The question of which agency is to inspect which food establishment often remains open until agreed upon by all agencies concerned. The field of regulatory enforcement is in constant flux with establishments coming into and going out of business, with often small operators working clandestinely, and with new concepts evolving continuously in the food processing and food service industries. The latter would be exemplified by a restaurant that would not only pass purchased food in altered form to in-house customers; but also create new foods, package them, and distribute them widely to retail and other establishments.

The basic laws for public protection and the creation of an orderly market are there. But it becomes a problem occasionally to match the regulator with the regulated properly.

Conclusion

In summary, there is no doubt that all types of food establishments are well regulated (indeed, in some cases, overregulated) and only occasionally, depending on state or federal funding, regulated in an unsatisfactory manner. There are, however, areas where there are no fixed guidelines for the entrepreneur about to make a major change, like entering interstate commerce, building a new plant, or updating an old plant. Not only are there no guidelines, manuals, or other written information, but it also seems extremely difficult to identify and meet with a federal regulatory official who is willing or authorized to spell out in writing the necessary requirements. This is so because the jurisdiction for many issues is not always clear-cut. It is also not absolutely certain up to which point a local federal inspector is authorized to make policy decisions.

There may, indeed, be answers available to most or all of the questions a food service entrepreneur raises. But if there are, they are definitely not readily available and an effort should be made, either through a recommendation from the General Accounting Office, or through the initiative of the respective agency, to communicate these answers better to the clientele that needs them.

APPENDIX

A Summary of Laws Administered by the Pennsylvania Department of Agriculture Bureau of Foods and Chemistry

FOODS AND CHEMISTRY

Specific General Authorization: Sections 1704, 1705, 1706, and 1711 Administrative Code of 1929, P.L. 177, as amended; and Executive Board Minutes of April 13, 1973

GENERAL FOOD LAW
(Act of May 13, 1909, P.L. 520, as amended)

Defines food; provides for the protection of public health, and the prevention of fraud and deception; prohibits the manufacture or sale, the offering for sale or exposing for sale, or the having in possession with intent to sell, of adulterated, misbranded, or deleterious foods; provides for the use of sulphur-dioxide in certain food items and defines labeling requirements relating to artificial sweetening agents, and provides penalties for violation.

DEPARTMENT OF AGRICULTURE RULES AND REGULATIONS:
(Contained in Title 7, Pennsylvania Code)

Chapter	35	Condiments, Spices, Pickles, and Related Products
	37	Frozen Foods
	41	Fruit and Fruit Products, Fruit Butters, Fruit Jellies, and Fruit Preserves
	43	Flavoring Materials
	45	General Foods
	47	Oleaginous Materials, Animal and Vegetable Fats and Oils
	53	Cider and Vinegar Standards
	63	Salad Dressings and Related Products

FARM PRODUCTS LAW
(Act of April 4, 1929, P.L. 144, as amended)

Prescribing the powers and duties of the Department of Agriculture with regard to farm products; providing for cooperation with the Bureau of Standard Weights and Measures to establish standard receptacles for farm products; authorizing the Department of Agriculture to establish and promulgate standards for the grade and other classification of farm products, and to promulgate regulations for the enforcement thereof; defining farm products to include agricultural, horticultural, vegetable, fruit, and floricultural products of the soil, livestock and meats, wool, hides, poultry, eggs, dairy products, nuts, mushrooms, and honey; and providing penalties.

DEPARTMENT OF AGRICULTURE RULES AND REGULATIONS:
(Contained in Title 7, Pennsylvania Code)

Chapter 85	Egg Certification
87	Standards for Grading and Marketing Eggs
89	Turkey and Poultry Improvement Plans
93	Controlled Atmosphere Storage for Apples
95	Certified Apple Program
97	Container Standards

BAKERY LAW
(Act of May 22, 1933, P.L. 912, as amended)

To protect the public health; defining and providing for the licensing of bakeries, and regulating the inspection, maintenance, and operation of bakeries, and premises, stores, and shops connected therewith; defining and regulating the manufacture, sale, and offering for sale of bakery products; conferring powers on the Department of Agriculture; and providing penalties; changing certain definitions; further regulating marking and labeling; conferring additional powers and duties on the Department of Agriculture; and further regulating the sale and importation of bakery products.

DEPARTMENT OF AGRICULTURE RULES AND REGULATIONS:
(Contained in Title 7, Pennsylvania Code)

Chapter 31	Bakeries and Bakery Products

BUTTER LAW
(Act of April 13, 1921, P.L. 129, as amended)

Providing for the protection of the public health and the prevention of fraud and deception by prohibiting the manufacture, the sale, the offering for sale, or exposing for sale, or the having in possession with intent to sell, of adulterated or deleterious butter; defining butter; and prescribing the penalty for the violation thereof, further defining butter and the adulteration of butter; conferring powers on the Department of Agriculture and the courts of quarter session; and providing penalties.

CANDY LAW
(Act of May 23, 1887, P.L. 157)

Prohibiting the manufacture for sale, sale, or offer to sell any candy or confectionery, adulterated by the mixture of terra alba, barytes, talc, or other mineral substances, or by poisonous colors, or flavors, or other ingredients, deleterious or detrimental to health, knowing the same to be so adulterated, or having such candy in possession by the manufacturer, and providing penalties for violations, and for enforcement.

CAUSTIC LAW
(Act of May 7, 1923, P.L. 139)

To regulate the sales of caustic acids, caustic alkalies, and preparations thereof, and mineral or chemical salts intended for household and agricultural uses; and providing penalties for violations.

COFFEE AND CHICORY LAW
(Act of May 5, 1915, P.L. 247)

Regulating the sale of chicory mixed with coffee, and providing a penalty.

DEPARTMENT OF AGRICULTURE RULES AND REGULATIONS:
(Contained in Title 7, Pennsylvania Code)

Chapter 55 Coffee and Tea Standards

COLD STORAGE LAW
(Act of May 20, 1949, P.L. 1511, as amended)

Defining cold storage; requiring licenses to operate cold storage warehouses and locker plants; requiring records, marking, wrapping, protecting, disposition, sale, return or transfer of foods in cold storage; conferring powers on the Department of Agriculture, including adoption of rules and regulations, special permits for storage of feeding stuffs for animal use, and providing penalties for violations.

COMPULSORY MARKING LAW
(Act of May 28, 1929, P.L. 86, as amended)

An Act relating to the grading and sale of grapes and potatoes in this Commonwealth; providing penalties for violations; and imposing certain duties upon the Department of Agriculture, by extending the provisions to apples and peaches, and permitting the grading, classifying and packing of grapes, potatoes, apples and peaches, other than those packed or repacked within this State.

EGGS UNFIT FOR FOOD LAW
(Act of March 11, 1909, P.L. 13, as amended)

Providing for the protection of the public health, by prohibiting the sale, offering for sale, exposing for sale, or having in possession with intent to sell, of eggs unfit for food, as therein defined, and prohibiting the use of such eggs in the preparation of food products; providing penalties for the violation thereof, and providing for the enforcement thereof, by providing for the licensing by the Department of Agriculture of persons, co-partnerships, associations and corporations engaged in the business of breaking eggs and separating the contents thereof for any purpose; regulating the opening of eggs unfit for food, and providing for the denaturing of such eggs; authorizing the Department of Agriculture to take samples of eggs for the purpose of analysis; further regulating the right to sell or otherwise deal with eggs subjected to incubation; providing that certain violations of the Act shall be punishable in summary proceedings; prescribing penalties; and repealing certain legislation.

EGG AND POULTRY RESEARCH
(Act of December 1, 1967, P.L. 668)

An Act authorizing the Department of Agriculture to establish facilities for and to conduct official egg-laying and pullet growing research tests; providing facilities for the same on property now under the control of the Pennsylvania State University; and providing for the disposition of income accruing under the Act.

DEPARTMENT OF AGRICULTURE RULES AND REGULATIONS:
(Contained in Title 7, Pennsylvania Code)

Chapter 89 Turkey and Poultry Improvement Plans

FRESH EGGS LAW
(Act of July 10, 1919, P.L. 900, as amended)

Relating to eggs, prohibiting the sale, offering for sale, exposing for sale, or having in possession with intent to sell, eggs, for and as fresh, that are not fresh eggs, or of branding or labeling or making eggs as being fresh eggs that are not fresh eggs, prescribing certain duties of the Department of Agriculture, and prescribing penalties for violations.

FRESH MEAT, POULTRY, GAME AND FISH LAW
(Act of March 28, 1905, P.L. 64, as amended)

To prohibit the selling, shipping, consigning, offering for sale, exposing for sale, or having in possession with intent to sell, as fresh, any meat, poultry, game, fish, or shell fish which contains any substance or article possessing a preservative or coloring character or action; making the same a misdemeanor; and to prescribe penalties and punishment for violation, and the means and the methods of procedure for enforcement.

FROZEN DESSERT LAW
(Act of September 1, 1965, P.L. 420, as amended)

For the protection of the public health, and to prevent fraud and deception in the manufacture, sale, offering for sale, exposing for sale, and possession with intent to sell, of adulterated or deleterious ice cream, frozen custard, french ice cream, french custard ice cream, sherbet, fruit sherbet, ice milk, ice, water ice quiescently frozen confections, quiescently frozen dairy confections, milk shakes, including coated ice cream and similar products and the coating thereof, fixing standards for ice cream, frozen custard, french ice cream, french custard ice cream, sherbet, fruit sherbet, ice milk, ice, water ice quiescently frozen confections, quiescently frozen dairy confections, and milk shakes, and to prevent sale of imitation of such products, providing for licensing, authorizing and regulating the manufacture and sale of artificially sweetened ice cream and ice milk for diabetics, conferring powers and imposing duties upon the Department of Agriculture, prescribing penalties, providing for the enforcement thereof, and making repeals, providing for licensing and regulating the manufacture and sale of frozen desserts.

DEPARTMENT OF AGRICULTURE RULES AND REGULATIONS:
(Contained in Title 7, Pennsylvania Code)

Chapter 39 Frozen Desserts Standards

FRUIT SYRUP LAW
(Act of March 3, 1925, P.L. 10, as amended)

Relating to fruit syrups, and prohibiting the manufacture, sale, offering for sale, exposing for sale, or having in possession with intent to sell, of any adulterated or misbranded fruit syrups; providing penalties for violation, and providing for enforcement.

IDENTITY OF MILK AND DAIRY PRODUCTS LAW
(Act of August 8, 1961, P.L. 975, as amended)

Defining milk and its derivatives, prohibiting its adulterations, regulating its labeling, sale and serving; imposing powers and duties on the Department of Agriculture; providing penalties and making repeals.

DEPARTMENT OF AGRICULTURE RULES AND REGULATIONS:
(Contained in Title 7, Pennsylvania Code)

Chapter 57 Milk and Dairy Products--General Provisions

LARD LAW
(Act of March 11, 1909, P.L. 17)

To protect the public health, and prevent fraud and deception in the manufacture or sale of lard, lard substitutes, imitation lard, and lard compounds; providing penalties for the violation thereof, and providing for enforcement.

MILK CAN LAW
(Act of July 2, 1935, P.L. 589, as amended)

To safeguard human health and life by providing for the issuance of permits to, and regulations of persons and entities selling milk and milk products; conferring powers, and imposing duties on the Secretary of Agriculture; and otherwise providing for the administration of the act; and imposing penalties.

DEPARTMENT OF AGRICULTURE RULES AND REGULATIONS:
(Contained in Title 7, Pennsylvania Code)

Chapter 59 Milk Sanitation and Standards

NON-ALCOHOLIC DRINKS LAW
(Act of July 5, 1957, P.L. 485, as amended)

For the protection of the public health and welfare, and the prevention of fraud and deception in the manufacture or sale of packaged non-alcoholic drinks; prohibiting the sale, offering or exposing for sale, exchange or giving away thereof unless registered; providing for licensing of places of manufacture; regulating the manufacture, compounding, labeling, sanitation and ingredients of non-alcoholic drinks, and the display of presses of fruit; prohibiting misbranding and adulteration of registered and non-registered non-alcoholic drinks; authorizing promulgation of rules, regulations and standards and providing for penalties and for injunctions in certain cases, and the disposition of fees and fines.

DEPARTMENT OF AGRICULTURE RULES AND REGULATIONS:
(Contained in Title 7, Pennsylvania Code)

Chapter 61 Packaged Non-Alcoholic Drinks

OLEOMARGARINE LAW
(Act of December 5, 1965, P.L. 1077)

Relating to and regulating the manufacture, sale, transportation, possession, use, serving and advertising of oleomargarine, margarine, butterine and similar substances; prohibiting the sale, possession or use thereof in certain cases; preventing and punishing fraud and deception in the manufacture, sale, use, serving and advertising thereof; imposing powers and duties on the Department of Agriculture and defining enforcement procedure; requiring notice to patrons of certain eating places which sell or serve any such products; and prescribing penalties.

OYSTER LAW
(Act of March 17, 1925, P.L. 34, as amended)

Regulating the sale of oysters at retail.

PAINT LAW
(Act of April 10, 1925, P.L. 229)

To prevent deception in, and to regulate the sale of, paint, putty, naval stores (turpentine, and rosin), or any substitutes therefore; providing penalties for violations; providing for enforcement, and repealing an act approved June 1, 1915.

PENNSYLVANIA MEAT AND POULTRY HYGIENE LAW OF 1968
(Act of July 9, 1968, P.L. 304)

Providing for the inspection of livestock and poultry slaughtered and the carcasses and parts thereof, meat food products and poultry products processed therefrom, for human consumption, at certain establishments, requiring licenses, making certain acts illegal, providing penalties and making an appropriation.

DEPARTMENT OF AGRICULTURE RULES AND REGULATIONS:
(Contained in Title 7, Pennsylvania Code)

Chapter 1 Meat Hygiene--Meat Product Standards

PROCESSED BUTTER LAW
(Act of July 10, 1901, P.L. 643)

Defining boiled or process butter; designating the name by which it shall be known, providing for the licensing of manufacturers and dealers therein, and regulating the sale and labeling of the same so as to prevent fraud and deception in its sale; providing punishment for violations of this act, the methods of procedure for its enforcement, and certain matters of evidence in such procedure.

PRODUCE DEALERS LICENSE LAW
(Act of May 27, 1937, P.L. 901, as amended)

For the protection of producers of farm produce; providing for the licensing and the regulation of certain dealers in farm produce, as herein defined, within this Commonwealth; conferring powers, and imposing duties on the Department of Agriculture; providing for appeals and injunctions; and prescribing penalties.

SANITARY CONTAINER LAW
(Act of May 21, 1937, P.L. 788)

For the protection of the public health, and the prevention of fraud and deception, requiring clean, sanitary establishments for the manufacture, preparation or bottling of non-alcoholic drinks and liquid foods, including clean, sanitary ingredients and containers; regulating the maintenance and operation of such establishments, and the use of containers; prescribing penalties; and providing for injunctions in certain cases.

SAUSAGE LAW
(Act of April 6, 1911, P.L. 51, as amended)

Providing for the protection of the public health and the prevention of fraud and deception, by prohibiting the sale, the offering for sale or exposing for sale, or having in possession with intent to sell, of adulterated or deleterious sausage; defining sausage; and prescribing the penalty for the violation thereof; further regulating the adulteration of sausages; changing the penalties prescribed; and providing for injunctions in certain cases.

THE DISTRIBUTION-TRANSPORTATION PROBLEM OF COMMISSARY OPERATIONS

by

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THE DISTRIBUTION-TRANSPORTATION PROBLEM OF COMMISSARY OPERATIONS*

Introduction

The increasing trend in food services toward convenience foods, commissaries, and central kitchens has increased enormously the complexity of service operations. Efficient management of such a complex operation is difficult at best without the aid of modern management methods. The techniques and tools of a management science called operations research (20,37) have been used successfully in many military and industrial management applications. Operations research is an analysis, usually involving the mathematical treatment of a process, problem, or operation, to determine its purpose and effectiveness and to gain maximum efficiency.

It was not until very recently (4) that these advanced methods were proposed for extensive use in the food service industry. Suggestions have been made that operations research methodology could be beneficially applied in the areas of inventory control and production management. It is also possible to use these techniques in facility planning. Interior design and size of production, storage and service facilities, and facility location are problems for which techniques are readily available for aiding food service decision makers. Many lease versus buy decisions and equipment replacement decisions are amenable to these methods.

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Questions about the costs and ultimate decisions of adding or deleting items from a product line are typical problems handled by these operations research techniques.

The planning of menus through the use of mathematical programming models has been applied successfully to yield diets of balanced nutritional value. Currently under investigation at the Pennsylvania State University is the combining of menu-planning and food purchasing policies for balanced diets at minimum cost. The commissary presents a problem of product distribution not unique to the food service industry. This distribution-transportation problem of moving foods from the commissary to the individual service units at minimum cost is the subject of the following section of this paper.

The Commissary Problem

The most recent of a series of studies, in which surveys of the food service industry are conducted every five years (28), reveals that the use of convenience foods has become standard operating procedure in every segment of the food service industry. This study indicates that use has almost doubled in the five-year period between surveys.

The advent of convenience food initiated the evolvement of two alternatives to combat the labor cost and productivity problems. First, an approach that can be utilized by both the individual restaurateur and the chain organizations is the purchase of convenience foods from their regular purveyors. A central commissary, the second method, is useful only to multi-restaurant operations. Both methods save time and labor, increase portion control, and decrease food production waste.

Marshall C. Warfel, Vice President of Food and Beverage Operations for I.T.T-Sheraton Corporation, in a recent article (38) cited three major reasons

why convenience foods are not being used as fully as their advantages suggest that they could be. High cost (frozen entrees cost, on the average of 2 to 2-1/2 times as much as the raw food products), inadequate quality, and insufficient variety tend to outweigh the advantages of convenience foods.

The commissary system presents a unique situation in which the disadvantages of convenience foods can be counteracted. Quantity purchasing decreases raw food cost. Control of amount and quality of purchased food is increased. The quality of the finished product can be directly regulated by management. Variety of products is limited only by facilities and capabilities of personnel.

Labor-saving equipment, like machines to wash, peel, and trim fruits and vegetables, which would be uneconomical in an individual operation, can be utilized in mass production. A large part of the high cost of labor is due to the need for skilled labor; this need in the individual operation is significantly reduced by the commissary (27).

Examples of the different types of food service companies presently operating commissaries are varied and plentiful. Approximately 80 percent of food vending companies operate their own commissaries. Pan American Airlines' frozen food commissary at the San Francisco Airport supplies food for flights all over the world. United Airlines has two commissaries, one at O'Hare Airport in Chicago and another smaller one in Portland, Oregon (36). Interstate Hosts, Inc., of Los Angeles has a commissary in Elkhart, Indiana, which distributes to 16 restaurants on the Indiana Turnpike. Van de Kamp's, also of Los Angeles, operates a commissary to supply its chain of six coffee shops (8). Horn and Hardhart's New York commissary produces food for over 50 units (11). Pacific Homes Corporation utilizes a commissary to supply six retirement homes in the Los Angeles-Phoenix area (8). The Ford Motor Company and Pratt Whitney

Aircraft Company use central processing in industrial feeding (39). McDonald's, Hot Shoppes, Inc., Marriott Corporation, the Pubs in the Philadelphia area, and various school lunch programs are other examples of commissary operations (1,30).

The commissary is not, however, without drawbacks, one of the most significant being the distribution of the product from the commissary to the individual service units. Although distribution must be contended with in either situation, purveyor or commissary, in the latter situation, it must be handled within the organization. Distribution costs, however, are ultimately paid by the receiver of the delivery. To the purveyor these costs are paid indirectly, and in a commissary they are direct costs of the operation. A dramatic illustration of the effect of distribution cost on commissary operations is the statistical fact that average distribution cost ranges from six to ten percent of sales (10). In some cases, this cost can offset the savings of mass production (23).

One marketing expert estimates that the food service industry is 15 years behind retail marketing in its fractionalized and hard-to-control system of distribution (25). The use of operations research and mathematical, optimization methodology to minimize transportation costs of the distribution process could alleviate this negative aspect of commissary operation. The purpose of this paper is to describe and demonstrate such a method.

A Mathematical Approach

The capabilities of the computer have been ignored by food distributors to the point where one observer has termed the computer as a "sleeping giant" insofar as food distribution is concerned(10). Therefore, successful applications of operations research to transportation problems in other industries

must be examined for basic similarity and adaptability to this food service industry problem.

This paper will describe the application of an algorithmic method to the distribution of food products from a central commissary to individual food service units. In operations research terminology this falls into the category of the "single terminal delivery problem." Several categories of methods have been proposed (35) to solve the single terminal delivery problem: (1) branch and bound, (2) integer programming, (3) dynamic programming, (4) heuristic programming, (5) simulation.

Branch and bound approaches have been presented by Hayes (18), Pierce (29), and Tillman (34). The computation time and memory space requirements of the branch and bound method makes it prohibitive for problems with more than 15 delivery points (5, 34).

The simulation technique was used by Braum for carrier dispatching (3) and by Newton and Thomas (26) to design school bus routes. Balinski and Quandt (2) presented integer programming as a solution method to the delivery problem. A dynamic programming method for sequencing problems, of which the delivery problem is a variation, was proposed by Held and Karp (19).

Most of the delivery problem work to appear in the literature has been done in heuristic programming (5, 7, 9, 13, 14, 15, 16, 17, 22, 31, 35). This is true apparently because it is currently the only approach computationally feasible for large problems (34). The use of heuristics for the single terminal delivery problem was first posed by Dantzig and Ramser (9). Elements of the problem include a set of customers to be supplied with some commodity from a depot by some type of delivery vehicle, given that the location of the customers, the demand for the commodity, and the capacities of the available vehicles are known. The problem is to design routes that minimize the total

delivery cost by minimizing the number of vehicles needed and the total distance covered, subject to these constraints:

1. All demand requirements must be met;
2. The capacity of the vehicles must not be exceeded; and
3. The total time required for each vehicle to complete a tour must not be greater than a pre-determined level (5).

Dantzig and Ramser's method of solution emphasized filling the delivery vehicles more than minimizing the distance.

Lin (24) viewed the problem as a chain connected by links and proposed a "2-optimal" tour which occurs when no improvement is possible by eliminating two links and replacing them with two others. This idea was expanded by Christofides and Eilon (5) to "r-optimal," but they state that although the probability that the r-optimal tour is minimal increases with r, the amount of computation involved in producing the r-optimal tour increases very rapidly with r.

Gillett's "sweep algorithm" (13) involves the use of the polar coordinates of each location relative to the distribution center in an iterative procedure to decrease the total distance for a route. Each delivery point is located graphically, and angles formed by lines linking the points are used to project the distances between the points. The delivery points are then numbered sequentially by the size of their polar coordinate angles. There are several variations to this iterative procedure, each of which can yield a different solution.

Clark and Wright (7) introduced a concept that is the basis of many other approaches (14-17, 22, 31, 34, 35, 36, 40). Their initial assumption is that one vehicle visits one customer and returns to the terminal. The next step is to examine the possibility of joining customer "a" and customer "b" to form

one tour, therefore eliminating one truck and saving the sum of the distances from the depot to customer "a" and from the depot to customer "b" less the distance between customer "a" and customer "b." Expressing this concept mathematically, we have

$$S_{ab} = d_{oa} + d_{ob} - d_{ab}$$

where S_{ab} is the savings realized in joining customer "a" and "b," d_{oa} and d_{ob} are the distances from the terminal to customers "a" and "b" respectively, and d_{ab} is the distance between customer "a" and customer "b." This is the basic savings equation. Since the distance between two given points is the same in both directions, a half-matrix instead of a full matrix is developed for distances and savings. All possible ab links are examined in the half-matrix, and each feasible link, according to capacity and time constraints, which yields the greatest savings, is added to the tour.

The logic leading to the "savings equation" is elementary and quite lucid. Consider a situation with P_0 as the distribution center and P_1 and P_2 as the demand points. If two trucks are available, each of which has the capacity to deliver the amounts required at each point, one truck would be assigned to each point. Therefore, the total distance covered by the trucks would be

$$2\ d_{01} + 2\ d_{02}$$

where d_{01} equals the distance between the distribution point P_0 and P_1, and where i takes values 1 and 2. Now assume that one of the trucks has the capacity to carry both amounts demanded at P_1 and P_2 simultaneously. In this case, the distance covered by the one truck, delivering to P_1 and P_2 would be

$$d_{01} + d_{12} + d_{20}$$

and the savings in distance would be

$$d_{01} + d_{02} - d_{12}$$

which is the "savings equation" mentioned previously.

Wright (40) further developed his previous work and devised a computer program in which distances can be calculated from grid coordinates enabling would-be users to test the possibility of using the method without going to the expense of creating a matrix of distances.

Another computer program based on Clark and Wright's work was developed by IBM. The IBM program incorporates the concept of zoning the delivery points into groups so that the number of points feasibly handled can be increased to 5000 (22).

Tillman, with his associates, has applied and developed the Clarke and Wright equation in three studies of the delivery problem. Tillman and Cochran (35) expand the basic "savings" concept so that instead of adding the link with the greatest savings at a particular point, the algorithm computes all possible connections for both the link that would produce the greatest savings and for the one producing the next-to-the-greatest savings, and selects the greatest overall savings. A solution to the delivery problem with multiple terminals and probabilistic demand, which is also rooted in the "savings" approach, has been presented by Tillman (33). The third application of the "savings" equation derived by Tillman and Cain (34) was mentioned earlier as a branch and bound method; although it was specifically designed for the multi-terminal delivery problem, it will also accommodate the single terminal problem as a special case of the multi-terminal problem.

Schruben and Clifton (31) also adopted the "savings equation." They called the savings "the distance saved coefficient," and once a point had been added to a tour it was locked in and no longer considered for linking; therefore they named their method "lockset."

Hallberg and Gentry (16) discovered the "savings equation" through Schruben and Clifton's "lockset method" and applied the concept to routing systems for retail milk delivery. Hallberg and Kriebel (17) modified the method to include additional constraints and have designed a computer program (15) to implement their version of the method.

Homer's work (21) explores a different aspect of the delivery problem, specifically the available storage space at the demand points. This factor must be considered in determining the time cycle over which the total demand must be delivered--for example, two or three deliveries per week. Time considerations, vehicle capacity, and demand for a product interact with storage and inventory constraints to determine delivery schedules for operations. In formulating his problem, Homer uses a factor to convert the delivered item and storage space into homogenous units, such as cubic feet. This concept is applicable also to vehicle capacity. The objective of the Homer study was to phase deliveries to meet space restrictions, but his solution is based on the premise that the cost of receiving "n" items all at once is equal to the cost of receiving the same number of items in mo-e than one delivery; in most situations, that assumption would be unrealistic.

The Hallberg Program for Vehicle Routing

Hallberg's version of the Clarke and Wright algorithm (15) seems to be the most appropriate for application to a commissary distribution situation based on adaptability, utility, and accessibility.

Reviewing the situation for which the original Clarke and Wright algorithm was devised, it appears that there are several points that directly parallel a commissary situation. The circumstances for which Clarke's work (6) was done follow:

1. The number of customers to be visited on any given day is the subset of a known finite set;
2. The actual load (demand) at each delivery point may vary up to one hour prior to the scheduling of vehicles;
3. Certain demand points require delivery at a certain time; and
4. The small size of some loads might tend to overburden a truck with a quantity of deliveries to be made so that the time involved would be impossible for one day's work, if the system were not otherwise constrained.

Each of the listed conditions can be directly related to the commissary distribution case. The number of food service facilities to be serviced from the commissary would comprise a known finite set, and, therefore, the number of facilities receiving deliveries on any given day would be a subset of that finite set. Situations in which the amount of a specific item to be delivered would not be known until immediately preceding the departure of the delivery vehicle from the commissary occur quite frequently when dealing with perishable food products in an industry in which demand is so erratic. Peak production and service periods inherent in the food service industry usually require deliveries to be received only during certain hours of the day. The load size condition can be related to the different sizes and different types of food service facilities to be serviced. Demand at a particular location is also affected by the type of items being delivered. For example, baked goods often

require small daily deliveries while frozen items can be delivered less frequently but in larger quantities.

Hallberg's program takes additional factors into consideration. Both total time and total distance of a single route can be restricted to some predetermined maximum level. Time could be important, for example, to meet union contract specifications for the truck drivers. Distance would be a factor if management did not want the driver to have to take time to refuel while on the route. Sometimes it may be difficult for certain types of delivery vehicles to service certain locations due to inadequate receiving docks. The program is designed to restrict delivery vehicle types as necessary. The desired starting time for the route must be specified, and the total number of stops to be served on a single route may be restricted. Perhaps the most significant consideration is that different amounts of time may be required to serve different delivery points; the time to be spent at each delivery point is part of the input data. All of these factors apply to a commissary distribution situation.

Of all the methods considered in his review, Gaskell (12) states that no method is uniformly better than any other method. Schruben and Clifton (31) analyzed 20 routes of 12 firms and determined that in no case did management procedures result in routes with fewer miles than the routes found using the appropriate version of their algorithmic method; their average distance savings ranged from eight to twelve percent, with some as high as twenty percent. Hallberg (14) states that although his approach does not guarantee that an optimal routing schema will be found, it generally outperforms any known feasible alternative including the human dispatcher.

Four types of data are required by the Halberg program: (1) problem identification, (2) distance data, (3) vehicle information, and (4) demand

point data. Problem identification simply consists of a title page and column header information.

Distance data includes distance between stops, the number of stops excluding the distribution center, and the distance between the distribution center and each stop.

Vehicle information consists of the number of categories of trucks and the numerical coding for each category, an alphanumeric description of each truck category, the number of trucks of each category that are available, the capacity of each category of truck in both weight and volume, the distance limit for each category of truck, the earliest time that a truck can leave the distribution center and the latest time it can return to the distribution center provided that it leaves at the earliest possible time.

The option to have the program calculate the cost of distribution is also available. If this option is to be taken, the fixed cost for vehicle operation, the cost per unit of distance of vehicle operation, and the hourly cost of vehicle operation must be supplied for each category of truck available.

The demand point data that must be supplied is the average vehicle driving speed in units of distance per hour, the earliest and latest time at which a lunch break must be scheduled, the length of the lunch break to be scheduled, an alphanumeric name and number for each stop, the demand in weight and volume, the time required to make the delivery, the earliest and latest times at which deliveries can be received, the truck category numbers which cannot be used to deliver to that stop, if any.

All the constraints imposed by the various types of data dictated by the user comprise the criteria for linking delivery points to form a route. The program examines each feasible link within the constraints and

selects those feasible linkages with the greatest associated savings, as computed in the savings matrix, until all demand has been satisfied. The resulting routes comprise a delivery schedule.

Application of the Hallberg Program to Commissary Distribution

Data had been obtained from a restaurant chain in a large metropolitan area, which operates a central commissary. The basic data were extracted, supplemented, when necessary, and manipulated into the required format to be used in the computer program.

The commissary is located in an outlying and developing section of the city, and the 29 delivery points are scattered throughout the immediate metropolitan area with a heavy concentration in the central city (as in Figure 1). Of the 29 delivery points, 21 are restaurants, six of which have retail sections within the restaurant, and eight are retail shops only. Frozen items manufactured in the commissary are packaged for retail sale.

Distances between all the delivery points were measured in both a mileage equivalent and a unit of time (minutes). Units of distance were calculated by placing a grid over an appropriate sized map of the city and locating all points on the grid. The streets of the city are positioned in a grid pattern, so this method seemed to produce a relatively realistic measure. The map scale provided a means of converting the grid units into mileage. Driver report sheets supplied both data on the time required to travel between the distribution center and the demand points, and on the time spent at each stop. Over 50 of these driver report sheets were analyzed. In the cases when a truck did not travel between certain points, the time that would be required was estimated, based on distance, available highways, and average driving speeds.

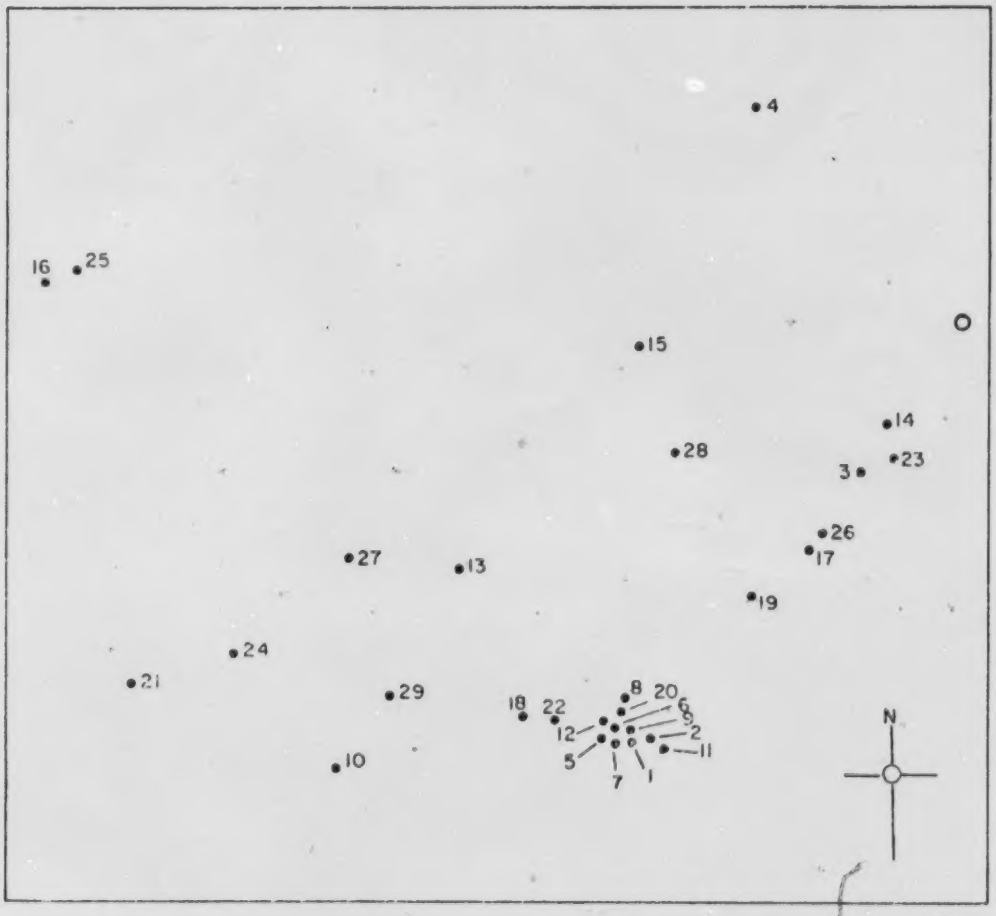

Figure 1

Location Of Delivery Points On Grid

For this particular company, the commissary was built much larger than was actually necessary to produce and supply convenience food items to the number of restaurants existing at that time; the original purpose was to provide for anticipated growth. Rather than waste additional available space, the commissary is also used as a warehouse. With few exceptions, all items required in operating a restaurant are purchased in bulk, are stored in the commissary, and are distributed to the restaurants as demanded. Under normal circumstances, a commissary is built to preprocess food items, package and freeze the items on the premises, and distribute the product to the company's food service operations. Since in this company the commissary is also used as a warehouse, distribution entails other than frozen products, and therefore required different types of delivery vehicles. Deliveries have been divided into three categories: baked goods, grocery items, and frozen items. Baked goods are delivered six days a week. Grocery items are delivered once a week. Frozen items are delivered once a week to locations with an adequate freezer storage area and twice a week to those locations that do not have a sufficient freezer storage area for a week's supply. An analysis of the items demanded over a four-week period at each delivery point revealed that frozen items comprise the largest segment of the delivered items (as in Table 1). This category includes pre-processed frozen convenience items and quantity purchased frozen items that are to be redistributed such as vegetables and meats.

A quality control requirement is that each delivery point turn over its entire inventory weekly. Menus in all the restaurants are basically the same, and all are on a weekly cycle. Demand at each restaurant remains relatively stable from week to week for all delivery categories. Table 2 shows total demand units for frozen items for the period studied. There

are a total of 96 items in the frozen food category, 44 manufactured frozen items, and 52 items purchased in quantity to be redistributed. (The itemized list appears in Appendix A.) All delivered products and delivery points have been numerically coded for ordering and inventory convenience.

TABLE 1

Percentages of Total Weekly Deliveries That Are Frozen Items

Week #	Manufactured Frozen Items	Quantity Purchased Frozen Items	Total Frozen
1	24.09	16.97	41.06
2	26.68	17.43	44.11
3	19.78	17.65	37.43
4	18.80	23.67	42.47

Computers are presently being used by the company to compile certain data. A printout of items delivered to each location, the unit size (e.g. case of #10 cans), the number of units, cost per unit, total cost, etc. is produced in triplicate--one copy each for the commissary file and the administrative office, and one to be signed by the manager of the delivery point upon receipt of the goods.

The average demand for each item at each location was calculated from the computer printouts for a four-week period. Demand in units was converted to weight in pounds and volume in cubic feet, and totaled in each category to yield a total demand in pounds and cubic feet for a period of a week for each location. The weight conversion was made by using the unit of measure for each item as specified in the printout. Volume was

derived from weight using a standard rule of thumb of 30 pounds of frozen food equals one cubic foot (32), as shown in Table 3.

The time required to deliver the amount demanded at each stop proved to be primarily a function of the amount delivered: more time being required to deliver larger quantities. Other factors considered as possibilities of influencing the time required at the individual stops were location of the stop (center city stops versus outlying stops), and the driver of the delivery truck.

Due to the cyclic nature of a restaurant's business, with peak production and service periods centering on the customary meal hours of breakfast, lunch, and dinner, deliveries during these peak periods are inconvenient, if not impossible. Company policy, in this sample case, requires the manager's signature to confirm delivered items and quantities, therefore making deliveries during particular hours virtually impossible. This constraint, detailed in Column 4 of Table 3, was determined on an individual delivery point basis; the location of the delivery point manager availability and traffic conditions also influence delivery times. Since the company from which data was received did not have any restrictions on the size of the vehicle to be used to deliver to any of the locations, that constraint option was not utilized in this sample problem.

The program was run several times, not only varying time and miles as distance measures, but also two sets of vehicular data (see Table 4). One set, set (a), corresponded to what was presently being used by the company, and the other, set (b), assumed that another, smaller category of trucks would be available for use. Routes for all categories of deliveries are now being scheduled by a human dispatcher: the method

TABLE 2

Unit Demand of Frozen Food Items for Four-Week Period[a]

Stop #	Week 1	Week 2	Week 3	Week 4	Average
1	392	317	361	357	357.00
2	271	289	366	110	259.00
3	252	189	235	253	232.25
4	248	266	301	236	262.75
5	435	260	508	190	348.25
6	294	287	302	118	250.25
7	432	380	408	480	425.00
8	156	168	139	42	126.25
9	471	581	508	526	521.50
10	202	209	350	111	218.00
11	102	166	80	87	108.75
12	153	246	269	177	211.25
13	208	307	350	225	272.50
14	296	375	482	421	393.50
15	200	252	174	215	210.25
16	191	194	251	198	208.50
17	147	146	96	98	121.75
18	115	62	182	138	124.25
19	191	234	180	200	201.25
20	191	199	195	160	186.25
21	63	148	187	160	139.50
22	30	11	11	18	17.50
23	23	32	9	22	21.50
24	23	47	44	40	38.50
25	31	43	34	37	36.25
26	30	43	34	36	40.75
27	11	17	22	17	16.75
28	24	49	16	30	29.75
29	81	127	51	90	62.50
	5628	5976	6625	4428	5182.50

[a]Demand units were taken from the frozen food section total of the company's computer printout, but are not homogenous units.

TABLE 3

Demand at Each Stop in Average Total Weight and Average Total Volume[a]

Stop #	Average Total Weight	Average Total Volume	Minutes Necessary To Make Delivery	Desired Arrival Time
1*	2112	71.90	23.80	9:00 A.M. - 11:45 A.M.
2*	2436	83.61	24.09	9:00 A.M. - 11:45 A.M.
3	1740	60.37	22.27	6:00 A.M. - 11:30 A.M.
4	2365	73.35	30.00	6:00 A.M. - 11:30 A.M.
5*	2808	93.94	22.72	9:00 A.M. - 11:45 A.M.
6*	1911	57.99	31.80	9:00 A.M. - 11:45 A.M.
7*	3233	90.61	36.80	9:00 A.M. - 11:45 A.M.
8*	1105	37.38	20.00	9:00 A.M. - 11:45 A.M.
9*	4495	149.83	35.50	9:00 A.M. - 11:45 A.M.
10	1227	40.68	19.50	6:00 A.M. - 11:30 A.M.
11*	1292	43.37	20.80	9:00 A.M. - 11:45 A.M.
12*	1684	52.68	23.60	9:00 A.M. - 11:45 A.M.
13	2474	81.30	25.00	6:00 A.M. - 11:30 A.M.
14	3507	116.37	25.70	6:00 A.M. - 11:30 A.M.
15	2030	67.68	28.30	6:00 A.M. - 11:30 A.M.
16	1390	46.33	21.00	6:00 A.M. - 11:30 A.M.
17	1288	42.88	27.00	8:00 A.M. - 11:30 A.M.
18	1932	64.37	14.58	8:30 A.M. - 11:30 A.M.
19	1893	63.37	37.80	8:00 A.M. - 11:30 A.M.
20*	1391	43.02	20.00	9:00 A.M. - 11:45 A.M.
21	1136	37.83	20.00	6:00 A.M. - 11:30 A.M.
22	200	6.66	11.40	8:30 A.M. - 4:00 P.M.
23	214	6.84	10.00	6:00 A.M. - 4:00 P.M.
24	333	11.07	17.50	6:00 A.M. - 4:00 P.M.
25	368	12.26	12.70	6:00 A.M. - 4:00 P.M.
26	230	7.65	17.00	6:00 A.M. - 4:00 P.M.
27	203	6.76	11.80	6:00 A.M. - 4:00 P.M.
28	283	9.43	13.57	6:00 A.M. - 4:00 P.M.
29	786	26.19	20.00	6:00 A.M. - 4:00 P.M.

[a]Average demand is on a weekly basis.

*Designates center city locations.

used is to group restaurants and retail shops by area and to calculate a tour length as close to eight hours as possible. A relatively rigid time schedule and a specific set of road arteries govern the routes. The trucks are loaded, checked, and sealed prior to the driver's starting time. Drivers are required to wait at each delivery point until the goods have been counted or weighed, and the manager has signed the invoice computer printout. Nine routes of approximately eight hours currently are deemed necessary to meet demand at the restaurants. The present routes, with numbers corresponding to the stop numbers in Table 2, follow:

Route 1: 7, 22, 18, 29, 10, 24, 27

Route 2: 1, 2, 8, 6, 5

Route 3: 9, 12, 20, 11

Route 4: 3, 17, 26, 19, 13

Route 5: 14, 15, 4, 16, 25

Route 6: 23, 18 29, 10, 21, 24

Route 7: 9, 7, 20, 12, 5, 11

Route 8: 14, 8, 1, 2, 28

Route 9: 3, 17, 19, 13

Assuming each of these routes to be approximately eight hours long, as they should be according to scheduling policy, the total amount of time required to cover these routes would be about 72 hours. Average cost figures supplied by the company are $.40 per mile to operate the truck, and the driver's wage rate is $4.275 per hour with a 20 percent benefit rate. The driver's time would therefore cost the company $357.36 for 72 hours. The total mileage for these nine routes computed through use of grid units described earlier is 427.95. At the company's rate,

TABLE 4

Vehicle Data Summary

Category	#	Description	Available[a]	Weight Capacity	Volume Capacity	Earliest Departure Time	Maximum Time On Route
(a)	1	18' Refrigerated	29	12,000	750	5:00 A.M.	8 Hours
	2	19' Refrigerated	3	13,000	800	5:00 A.M.	8 Hours
(b)	1	12' Refrigerated	29	8,000	500	5:00 A.M.	8 Hours
	2	18' Refrigerated	29	12,000	750	5:00 A.M.	8 Hours
	3	19' Refrigerated	29	13,000	800	5:00 A.M.	8 Hours

[a]For the algorithm to work there must be available a number of trucks of the smallest capacity equal to the number of stops to be made. This number is of course reduced in the final schedule.

the total operating cost to cover those routes would be $117.18. The average total delivery cost for the present routes would therefore be $486.54.

In order to simplify and to express uniformly the actual demand at each unit, the menu cycle and inventory turnover period of one week was also used as the time period for demand. Complications arose, however, in attempting to simulate actual conditions for running the program so that the results could be realistically compared to the actual situation. Due to the lack of adequate freezer storage space, 18 of the 29 delivery points require twice-a-week delivery; the commissary handles this situation by scheduling one main delivery and one small delivery to meet the weekly demand.

To cope with this situation, the 29 points had to be run on one program using the main delivery quantity, approximately 75 percent of total weekly demand, and the 18 points requiring a second delivery had to be set up as a separate problem using the smaller second delivery quantity. The first run, using the principal quantities, produced five routes requiring a total of 22.9 hours and 217.6 miles (calculated by the previously described grid units) to make the deliveries. Total delivery cost of these routes, based on the cost figures supplied by the company of $4.275 per hour of a driver's time plus a 20 percent benefit rate and $.40 per mile operating cost for each truck would be $204.54, $97.70 for the driver's time, $19.58 for benefit costs, and $87.06 for truck operation costs. Three more routes would be required to make a second delivery to the 18 locations that needed twice-a-week delivery. These additional routes would take 14.7 hours of time and cover 117.5 miles. The cost involved in these three routes, based on the same

figures as the previous calculation, would be $62.84 for the driver's time, $12,57 benefit cost, and $47.00 operating expense, for a total of $122.41. Therefore, the grand total of servicing the eight routes to deliver all of the demand would be $326.95. Compared to the present cost of $486.54, as computed in a previous section, the potential savings of these proposed routes would be $159.59 per week or $8,508.68 annually or an annual percentage savings of 32.8 percent. The computer routes would call for two 18-foot trucks, but would require only one driver because several of the routes could be neatly combined into a single day's work. By combining the routes, a five-day work week of 37.6 hours is projected. These results are summarized in Table 5. Lunch breaks are scheduled for four of the eight routes, and the required time of delivery for each location has been successfully met. (See Appendix B).

TABLE 5

Summary of Proposed Schedule of Routes

Route #	Lunch Break	Hours on Route	Miles on Route
1	no	3.70	36.45
2	no	3.55	50.10
3	yes	4.80	36.60
4	no	3.82	23.10
5	yes	7.03	71.40
6	no	3.27	23.10
7	yes	4.55	36.60
8	yes	6.87	57.75
		37.58	335.10

Another alternative requires that the storage space situation at those units that must have deliveries twice a week be remedied to allow once-a-week deliveries for all units. The second set of vehicular data,

that is, including the small 12-foot truck, and the units of distance in minutes were used for this alternative. Approaching the demand with this data, the program yielded five routes (see Appendix C) and only 22.9 total hours would be required to serve the routes. Grid unit calculations for the routes total 236.7 miles. Using the same cost figures as for the present situation, $4.275 per hour plus a 20 percent benefit rate and $.40 per mile operating cost for the truck the time cost is $117.48 and the distance cost is $94.68. Therefore, total delivery cost is only $212.16 as compared to $486.54 for the present method. This $274.38 per week delivery cost savings equals $14,267.76 on an annual basis or an annual percentage savings of 56.4. A summary of costs and potential savings is presented in Table 6.

TABLE 6

Comparison of Weekly Delivery Costs: Present vs. Proposed

Costs	Present Cost	Same data Computer Schedule Cost	Same data Computer Schedule Savings	Proposed[a] Computer Schedule Cost	Proposed[a] Computer Schedule Savings
Driver's Time	$307.80	$160.74	$147.06	$ 97.90	$209.90
20 Percent Benefit Rate	61.56	32.16	28.91	19.58	41.98
Truck Operation	117.18	134.06	-16.88	94.68	22.50
TOTAL	$486.54	$326.95	$159.59	$212.16	$274.38

[a]Once a week delivery to all delivery points and an additional delivery vehicle as described in above text.

Implications for the Food Service Industry

Based on the potential savings computed in this study of a relatively small metropolitan commissary operation, implications for the food service industry itself is dependent on the continuation of the commissary trend. Since distribution cost is a major factor in the operation of a commissary, this method could certainly contribute to the continuation of the trend. To those companies now operating commissaries, the savings resulting from the use of this method could increase overall profit or in some cases might save the operation from going out of business.

A logical assumption, stemming from the results of this study, would be that the potential savings from the use of the method would increase with the number of delivery points involved, Another factor to be considered is the rapid escalation in the cost of labor and operation of vehicles; this would also increase the value of the method.

The cost of using this method is neglibile compared to the potential savings from its use. Data required to implement the method is basic data which should be available or collectable in any operation. Once the data has been extracted and arranged in the proper format, the program can be used as often as necessary with only minor alterations to conform to the unavoidable changes that will occur. The average market cost of the computer time to the user for a problem of this size would be about $6.00 per schedule. The potential savings in a delivery cost and annual salary of a human dispatcher--each are obviously far greater than that figure.

There are several other possibilities for the use of the program to provide supplementary data to be considered in certain management decisions for delivery vehicles, and cost analyses of increasing storage

facilities are a few of the decisions for which the program's output could be used.

The program could be used as an aid to site location by computing the cost of distribution from alternate sites. Management might seek a site for the commissary itself prior to conversion to a commissary system. A site for another commissary might be under management's consideration. Distribution costs for the proposed additional commissary and its effects on the distribution costs of the present commissary could be projected to determine the potential profitability of the possible move.

Effects of adding or deleting a product in the line on the total distribution cost could be calculated by estimating demand for the product at each delivery point and then adding or subtracting the estimated demand from the total demand at each delivery point. Then the program could be run with the revised demand figures to calculate the new cost of distribution, which in turn, could be used to determine the effect on profit of the addition or deletion of the product.

Varying the sizes of the vehicles to be used for distribution in the program to compute the distribution costs for different combinations of vehicles could feasibly demonstrate that it would be more economical to distribute with a combination other than the present one. For example, in the second computer schedule, the addition of a smaller delivery vehicle produced an additional $5,759.08 potential annual savings. In this company, significant management questions would be does this additional potential savings warrant changing the present delivery vehicle combination: and if it does which method would result in the greatest overall savings, lease or purchase?

Another aspect of commissary decision making for which management might be able to utilize the program is deciding on the size of storage facilities at each delivery point. It was pointed out previously that inadequate storage facilities at over half the delivery points necessitated twice-a-week deliveries. The program could also be used to isolate the net cost of increasing storage facilities at each delivery point by offsetting the cost with the resultant savings in distribution cost. The ultimate value of the program to an organization as a management decision-making tool is dependent on the size of the overall operation and the imagination and progressiveness of its management.

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Appendix A

List of Frozen Items Distributed From the Commissary

Item Description

Manufactured Frozen Items

Baked Beans
Baked Macaroni
Macaroni in Cheese
Beef Stew
Beef Stroganoff
Beef Burgundy
Escalloped Beef and Macaroni
Chicken a la King
Chicken Veleoute
Creamed Chipped Beef
Sauce--Creole
Sauce--Tomato with Meat
Sauce--Barbeque with Beef
Delmonico Potatoes
Creole Spaghetti Sauce
Creamed Spinach
Lamb Stew
Salisbury Steak
Vegetable Chow Mein
Seafood Newburg
Harvard Beets
Mashed Turnips

Packaged For Retail Sale in Restaurants and Retail Outlets

Baked Beans
Baked Macaroni
Beef Burgundy
Beef Stew
Beef Pie
Chicken a la King
Chicken Pie
Creamed Spinach
Lamb Stew
Mashed Turnips
Mashed Sweet Potatoes
Pumpkin Pie
Fish Cakes
Chicken Croquettes
Chocolate Whipped Cream Cake
Donuts--Cream
Donuts--Jelly
Cake Roll--Chocolate
Cream Puffs
Blueberry Muffins
Leafettes

Redistributed Frozen Items

Beef Liver
Corned Beef
Veal Cutlet
Veal Parmesan
Veal Steak--Breaded
Veal Patties--Breaded
Pork Chops--7 ounce
Pork Chops--5 ounce
Spare Ribs
Steak--Sandwich
Steak--Dinner
Steak--Lunch
Beef Patties
Chopped Steak--2 ounce
Chopped Steak--3 ounce
Chopped Steak--4 ounce
Chopped Steak--5 ounce
Chopped Round Steak--5 ounce
Chopped Steak--8 ounce
Meatballs--Uncooked
Meatloaf--Cooked
Chicken--Prebreaded
Chicken--Diced
Turkey Breasts
Cod
Crab Cakes
Fish Cakes
Flounder

Appendix A (continued)

Item Description

Redistributed Frozen Items

Halibut
Scallops
Shrimp--Butterfly
Shrimp--Breaded
Smelts
Turbot
Cod--Prebreaded
Shrimp--Stuffed
French Fries--Straight Cut
French Fries--Crinkle Cut
Broccoli Spears
Corn--Whole
Carrots--Sliced
Lima Beans
Mixed Vegetables
Peas
Spinach Leaf
String Beans
Succotash
Ravioli--Cheese
Short Cake Layers
Pie Tops
Whipped Topping
Orange Juice

Appendix B

Route 1 An Algorithmic Approach To Commissary Distribution

STOP		AMOUNT DELIVERED	TIME AT STOP	EARLIEST ARRIVAL TIME	LATEST ARRIVAL TIME	ESTIMATED ARRIVAL TIME
TRUCK SHOULD LEAVE DISTRIBUTION CENTER AT						8:22AM DAY 1
9	HOUSE #23 & RETAIL #40	3371	0.36	9:00AM	11:45AM	9:00AM
5	HOUSE #9	2116	0.23	9:00AM	11:45AM	9:42AM
12	HOUSE #31	1263	0.24	9:00AM	11:45AM	10:12AM
2	HOUSE #3 & RETAIL #22	1827	0.24	9:00AM	11:45AM	10:45AM
11	HOUSE #29	929	0.21	9:00AM	11:45AM	11:13AM
TRUCK SHOULD RETURN TO DISTRIBUTION CENTER AT						12:04PM

AMOUNT DELIVERED ON ROUTE= 9506 POUNDS 308 CU FT
DISTANCE TRAVELED ON ROUTE= 94
TIME REQUIRED TO SERVE ROUTE= 3.70 HOURS

ROUTE REQUIRES A TRUCK WITH A CAPACITY OF 12000 POUNDS
750 CU FT
TYPE: 2
18' REFRI

Appendix B (continued)

Route 2 An Algorithmic Approach To Commissary Distribution

STOP	AMOUNT DELIVERED	TIME AT STOP	EARLIEST ARRIVAL TIME	LATEST ARRIVAL TIME	ESTIMATED ARRIVAL TIME
TRUCK SHOULD LEAVE DISTRIBUTION CENTER AT					5:52AM DAY 1
4 HOUSE #7	2365	0.30	6:00AM	11:30AM	6:21AM
28 RETAIL #6	283	0.14	6:00AM	4:00PM	7:14AM
13 HOUSE #32 & RETAIL #48	1656	0.25	6:00AM	11:30AM	7:43AM
18 HOUSE #40	1449	0.15	8:30AM	11:00AM	8:30AM
TRUCK SHOULD RETURN TO DISTRIBUTION CENTER AT					9:25AM

AMOUNT DELIVERED ON ROUTE= 5753 POUNDS 185 CU FT
DISTANCE TRAVELED ON ROUTE = 129
TIME REQUIRED TO SERVE ROUTE = 3.55 HOURS

ROUTE REQUIRES A TRUCK WITH A CAPACITY OF 12000 POUNDS
750 CU FT
TYPE: 2
18' REFRI

177

Appendix B (continued)

Route 3 An Algorithmic Approach To Commissary Distribution

STOP		AMOUNT DELIVERED	TIME AT STOP	EARLIEST ARRIVAL TIME	LATEST ARRIVAL TIME	ESTIMATED ARRIVAL TIME
TRUCK SHOULD LEAVE DISTRIBUTION CENTER AT						8:44AM Day 1
6	HOUSE #10	1911	0.32	9:00AM	11:45AM	9:30AM
	30-MINUTE LUNCH BREAK					
7	HOUSE #12	2425	0.37	9:00AM	11:45AM	10:47AM
1	HOUSE #1	1584	0.24	9:00AM	11:45AM	11:29AM
20	HOUSE #46	1043	0.20	9:00AM	11:45AM	12:04PM
8	HOUSE #14	829	0.20	9:00AM	11:45AM	12:30PM
TRUCK SHOULD RETURN TO DISTRIBUTION CENTER AT						1:32PM

AMOUNT DELIVERED ON ROUTE= 7792 POUNDS 255 CU FT
DISTANCE TRAVELED ON ROUTE= 125
TIME REQUIRED TO SERVE ROUTE= 4.80 HOURS

ROUTE REQUIRES A TRUCK WITH A CAPACITY OF 12000 POUNDS
750 CU FT
TYPE: 2
18' REFRI

Appendix B (continued)

Route 4 An Algorithmic Approach to Commissary Distribution

STOP		AMOUNT DELIVERED	TIME AT STOP	EARLIEST ARRIVAL TIME	LATEST ARRIVAL TIME	ESTIMATED ARRIVAL TIME
TRUCK SHOULD LEAVE DISTRIBUTION CENTER AT						6:37AM DAY 1
14	HOUSE #34 & RETAIL #28	2630	0.26	6:00AM	11:30AM	6:55AM
26	RETAIL #30	230	0.17	6:00AM	4:00PM	7:31AM
17	HOUSE #39 & RETAIL #19	966	0.27	8:00AM	11:30AM	7:57AM
19	HOUSE #42 & RETAIL #21	1410	0.38	8:00AM	11:30AM	8:40AM
3	HOUSE #6	1305	0.22	6:00AM	11:30AM	9:31AM
23	RETAIL #43	214	0.10	6:00AM	4:00PM	10:01AM
TRUCK SHOULD RETURN TO DISTRIBUTION CENTER AT						10:26AM

AMOUNT DELIVERED ON ROUTE= 6755 POUNDS 216 CU FT
DISTANCE TRAVELED ON ROUTE= 89
TIME REQUIRED TO SERVE ROUTE= 3.82 HOURS

ROUTE REQUIRES A TRUCK WITH A CAPACITY OF 12000 POUNDS
750 CU FT
TYPE: 2
18' REFRI

Appendix B (continued)

Route 5 An Algorithmic Approach To Commissary Distribution

STOP	AMOUNT DELIVERED	TIME AT STOP	EARLIEST ARRIVAL TIME	LATEST ARRIVAL TIME	ESTIMATED ARRIVAL TIME
TRUCK SHOULD LEAVE DISTRIBUTION CENTER AT					5:40AM DAY 1
15 HOUSE #36	2030	0.28	6:00AM	11:30AM	6:30AM
16 HOUSE #38	1390	0.21	6:00AM	11:30AM	7:24AM
25 RETAIL #31	268	0.13	6:00AM	4:00PM	7:52AM
27 RETAIL #14	203	0.12	6:00AM	4:00PM	8:29AM
24 RETAIL #42	167	0.18	6:00AM	4:00PM	8:56AM
21 HOUSE #48	1136	0.20	6:00AM	11:30AM	9:29AM
10 HOUSE #25	820	0.20	6:00AM	11:30AM	10:12AM
30-MINUTE LUNCH BREAK					
29 RETAIL #1	408	0.20	6:00AM	4:00PM	11:17AM
22 RETAIL #46	200	0.11	8:30AM	4:00PM	11:57AM
TRUCK SHOULD RETURN TO DISTRIBUTION CENTER AT					12:42PM

AMOUNT DELIVERED ON ROUTE= 6622 POUNDS 222 CU FT
DISTANCE TRAVELED ON ROUTE= 229
TIME REQUIRED TO SERVE ROUTE= 7.03 HOURS

ROUTE REQUIRES A TRUCK WITH A CAPACITY OF 12000 POUNDS
750 CU FT
TYPE: 2
18' REFRI

Appendix B (continued)

Route 6 An Algorithmic Approach To Commissary Distribution

STOP	AMOUNT DELIVERED	TIME AT STOP	EARLIEST ARRIVAL TIME	LATEST ARRIVAL TIME	ESTIMATED ARRIVAL TIME
TRUCK SHOULD LEAVE DISTRIBUTION CENTER AT					8:04AM DAY 1
13 HOUSE #39 & RETAIL #19	322	0.27	8:00AM	11:30AM	8:30AM
15 HOUSE #42 & RETAIL #21	483	0.38	8:00AM	11:30AM	9:13AM
3 HOUSE #6	435	0.22	6:00AM	11:30AM	10:04AM
12 HOUSE #34 & RETAIL #28	877	0.26	6:00AM	11:30AM	10:36AM
TRUCK SHOULD RETURN TO DISTRIBUTION CENTER AT					11:20AM
AMOUNT DELIVERED ON ROUTE=	2117 POUNDS		67 CU FT		
DISTANCE TRAVELED ON ROUTE=	83				
TIME REQUIRED TO SERVE ROUTE=	3.27 HOURS				

ROUTE REQUIRES A TRUCK WITH A CAPACITY OF 12000 POUNDS
750 CU FT
TYPE: 1
18' REFRI

Appendix B (continued)

Route 7 An Algorithmic Approach To Commissary Distribution

STOP	AMOUNT DELIVERED	TIME AT STOP	EARLIEST ARRIVAL TIME	LATEST ARRIVAL TIME	ESTIMATED ARRIVAL TIME
TRUCK SHOULD LEAVE DISTRIBUTION CENTER AT					8:48AM DAY 1
4 HOUSE #9	692	0.23	9:00AM	11:45AM	9:30AM
30-MINUTE LUNCH BREAK					
5 HOUSE #12	808	0.37	9:00AM	11:45AM	10:36AM
1 HOUSE #1	528	0.24	9:00AM	11:45AM	11:18AM
16 HOUSE #46	348	0.20	9:00AM	11:45AM	11:53AM
6 HOUSE #14	276	0.20	9:00AM	11:45AM	12:19PM
TRUCK SHOULD RETURN TO DISTRIBUTION CENTER AT					1:21PM

AMOUNT DELIVERED ON ROUTE= 2652 POUNDS 89 CU FT
DISTANCE TRAVELED ON ROUTE= 119
TIME REQUIRED TO SERVE ROUTE= 4.55 HOURS

ROUTE REQUIRES A TRUCK WITH A CAPACITY OF 12000 POUNDS
750 CU FT
TYPE: 1
18' REFRI

Appendix B (continued)

Route 8 An Algorithmic Approach To Commissary Distribution

STOP		AMOUNT DELIVERED	TIME AT STOP	EARLIEST ARRIVAL TIME	LATEST ARRIVAL TIME	ESTIMATED ARRIVAL TIME
TRUCK SHOULD LEAVE DISTRIBUTION CENTER AT						5:58AM DAY 1
11	HOUSE #32 & RETAIL #48	818	0.25	6:00AM	11:30AM	6:30AM
17	RETAIL #42	167	0.18	6:00AM	4:00PM	7:21AM
8	HOUSE #25	407	0.20	6:00AM	11:30AM	7:56AM
18	RETAIL #1	408	0.20	6:00AM	4:00PM	8:31AM
14	HOUSE #40	483	0.15	8:30AM	11:00AM	9:09AM
10	HOUSE #31	421	0.24	9:00AM	11:45AM	9:34AM
2	HOUSE #3 & RETAIL #22	609	0.24	9:00AM	11:45AM	10:07AM
9	HOUSE #29	323	0.21	9:00AM	11:45AM	10:35AM
	30-MINUTE LUNCH BREAK					
7	HOUSE #23 & RETAIL # 40	1124	0.36	9:00AM	11:45AM	11:36AM
TRUCK SHOULD RETURN TO DISTRIBUTION CENTER AT						12:50PM

AMOUNT DELIVERED ON ROUTE= 4760 POUNDS 157 CU FT
DISTANCE TRAVELED ON ROUTE= 179
TIME REQUIRED TO SERVE ROUTE= 6.87 HOURS

ROUTE REQUIRES A TRUCK WITH A CAPACITY OF 12000 POUNDS
750 CU FT
TYPE: 1
18' REFRI

Appendix B (continued)

Route Summary

ROUTE	CUSTOMERS SERVED	QUANTITY DELIVERED		DISTANCE TRAVELED	HOURS SPENT	TIME TO BEGIN ROUTE	TIME TO END ROUTE	HOURS STEM DRIVING	TRUCK TYPE	
		WGT	CU FT							
1	5	9506	308	94	3.70	8:22AM	12:04PM	1.13	2	18' REFRI
2	4	5753	185	129	3.55	5:52AM	9:25AM	1.15	2	18' REFRI
3	5	7792	255	125	4.80	8:44AM	1:32PM	1.47	2	18' REFRI
4	6	6755	216	89	3.82	6.37AM	10.26AM	0.55	2	18' REFRI
5	9	6622	222	229	7.03	5:40AM	12:42PM	1.40	2	18' REFRI
6	4	2117	67	83	3.27	8:04AM	11:20AM	0.73	2	18' REFRI
7	5	2652	89	119	4.55	8:48AM	1:21PM	1.40	2	18' REFRI
8	9	4760	157	179	6.87	5:58AM	12:50PM	1.17	2	18' REFRI
TOTALS	47	45947	1499	1047	37.58			9.00		

Appendix C

Route 1 An Algorithmic Approach To Commissary Distribution

STOP		AMOUNT DELIVERED	TIME AT STOP	EARLIEST ARRIVAL TIME	LATEST ARRIVAL TIME	ESTIMATED ARRIVAL TIME
TRUCK SHOULD LEAVE DISTRIBUTION CENTER AT						8:22AM DAY 1
9	HOUSE #23 & RETAIL #40	4495	0.36	9:00AM	11:45AM	9:00AM
5	HOUSE #9	2808	0.23	9:00AM	11:45AM	9:42AM
12	HOUSE #31	1684	0.24	9:00AM	11:45AM	10:12AM
2	HOUSE #3 & RETAIL #22	2436	0.24	9:00AM	11:45AM	10:45AM
11	HOUSE #29	1292	0.21	9:00AM	11:45AM	11:13AM
TRUCK SHOULD RETURN TO DISTRIBUTION CENTER AT						12:04PM

AMOUNT DELIVERED ON ROUTE= 12715 POUNDS 424 CU FT
DISTANCE TRAVELED ON ROUTE= 94
TIME REQUIRED TO SERVE ROUTE= 3.70 HOURS

ROUTE REQUIRES A TRUCK WITH A CAPACITY OF 13000 POUNDS
800 CU FT
TYPE: 3
19' REFRI

Appendix C (continued)

Route 2 An Algorithmic Approach To Commissary Distribution

STOP	AMOUNT DELIVERED	TIME AT STOP	EARLIEST ARRIVAL TIME	LATEST ARRIVAL TIME	ESTIMATED ARRIVAL TIME
TRUCK SHOULD LEAVE DISTRIBUTION CENTER AT					5:52AM DAY 1
4 HOUSE #7	2365	0.30	6:00AM	11:30AM	6:21AM
28 RETAIL #6	283	0.14	6:00AM	4:00PM	7:14AM
13 HOUSE #32 & RETAIL #48	2474	0.25	6:00AM	11:30AM	7:43AM
18 HOUSE #40	1932	0.15	8:30AM	11:00AM	8:30AM
TRUCK SHOULD RETURN TO DISTRIBUTION CENTER AT					9:25AM
AMOUNT DELIVERED ON ROUTE=	7054 POUNDS		227 CU FT		
DISTANCE TRAVELED ON ROUTE=	129				
TIME REQUIRED TO SERVE ROUTE=	3.55 HOURS				

ROUTE REQUIRES A TRUCK WITH A CAPACITY OF 8000 POUNDS
500 CU FT
TYPE: 1
12' REFRI

Appendix C (continued)

Route 3 An Algorithmic Approach To Commissary Distribution

STOP		AMOUNT DELIVERED	TIME AT STOP	EARLIEST ARRIVAL TIME	LATEST ARRIVAL TIME	ESTIMATED ARRIVAL TIME
TRUCK SHOULD LEAVE DISTRIBUTION CENTER AT						8:44AM DAY 1
6	HOUSE #10	1911	0.32	9:00AM	11:45AM	9:30AM
	30-MINUTE LUNCH BREAK					
7	HOUSE #12	3233	0.37	9:00AM	11:45AM	10:47AM
1	HOUSE #1	2112	0.24	9:00AM	11:45AM	11:29AM
20	HOUSE #46	1391	0.20	9:00AM	11:45AM	12:04PM
8	HOUSE #14	1105	0.20	9:00AM	11:45AM	12:30PM
TRUCK SHOULD RETURN TO DISTRIBUTION CENTER AT						1:32PM

AMOUNT DELIVERED ON ROUTE= 9752 POUNDS 302 CU FT
DISTANCE TRAVELED ON ROUTE= 125
TIME REQUIRED TO SERVE ROUTE= 4.80 HOURS

ROUTE REQUIRES A TRUCK WITH A CAPACITY OF 12000 POUNDS
750 CU FT
TYPE: 2
18' REFRI

Appendix C (continued)

Route 4 An Algorithmic Approach To Commissary Distribution

STOP	AMOUNT DELIVERED	TIME AT STOP	EARLIEST ARRIVAL TIME	LATEST ARRIVAL TIME	ESTIMATED ARRIVAL TIME
TRUCK SHOULD LEAVE DISTRIBUTION CENTER AT					6:37AM DAY 1
14 HOUSE #34 & RETAIL #28	3507	0.26	6:00AM	11:30AM	6:55AM
26 RETAIL #30	230	0.17	6:00AM	4:00PM	7:31AM
17 HOUSE #39 & RETAIL #19	1288	0.27	8:00AM	11:30AM	7:57AM
19 HOUSE #42 & RETAIL #21	1893	0.38	8:00AM	11:30AM	8:40AM
3 HOUSE #6	1740	0.22	6:00AM	11:30AM	9:31AM
23 RETAIL #43	214	0.10	6:00AM	4:00PM	10:01AM
TRUCK SHOULD RETURN TO DISTRIBUTION CENTER AT					10:26AM

AMOUNT DELIVERED ON ROUTE= 8872 POUNDS 298 CU FT
DISTANCE TRAVELED ON ROUTE= 89
TIME REQUIRED TO SERVE ROUTE= 3.82 HOURS

ROUTE REQUIRES A TRUCK WITH A CAPACITY OF 12000 POUNDS
750 CU FT
TYPE: 2
18' REFRI

Appendix C (continued)

Route 5 An Algorithmic Approach To Commissary Distribution

STOP		AMOUNT DELIVERED	TIME AT STOP	EARLIEST ARRIVAL TIME	LATEST ARRIVAL TIME	ESTIMATED ARRIVAL TIME
TRUCK SHOULD LEAVE DISTRIBUTION CENTER AT						5:40AM DAY 1
15	HOUSE #36	2030	0.28	6:00AM	11:30AM	6:30AM
16	HOUSE #38	1390	0.21	6:00AM	11:30AM	7:24AM
25	RETAIL # 31	268	0.13	6:00AM	4:00PM	7:52AM
27	RETAIL #14	203	0.12	6:00AM	4:00PM	8:29AM
24	RETAIL #42	333	0.18	6:00AM	4:00PM	8:56AM
21	HOUSE #48	1136	0.20	6:00AM	11:30AM	9:29AM
10	HOUSE #25	1227	0.20	6:00AM	11:30AM	10:12AM
	30-MINUTE LUNCH BREAK					
29	RETAIL #1	816	0.20	6:00AM	4:00PM	11:17AM
22	RETAIL #46	200	0.11	8:30AM	4:00PM	11:57AM
TRUCK SHOULD RETURN TO DISTRIBUTION CENTER AT						12:42PM

AMOUNT DELIVERED ON ROUTE= 7603 254 CU FT
DISTANCE TRAVELED ON ROUTE = 229
TIME REQUIRED TO SERVE ROUTE= 7.03 HOURS

ROUTE REQUIRES A TRUCK WITH A CAPACITY OF 8000 POUNDS
500 CU FT
TYPE: 1
12' REFRI

Appendix C (continued)

Route Summary

ROUTE	CUSTOMERS SERVED	QUANTITY DELIVERED		DISTANCE TRAVELED	HOURS SPENT	TIME TO BEGIN ROUTE	TIME TO END ROUTE	HOURS STEM DRIVING	TRUCK TYPE
		WGT	CU FT						
1	5	12715	424	94	3.70	8:22AM	12:04PM	1.13	3 19' REFRI
2	4	7054	227	129	3.55	5:52AM	9:25AM	1.15	1 12' REFRI
3	5	9752	302	125	4.80	8:44AM	1.32PM	1.47	2 18' REFRI
4	6	8872	298	89	3.82	6:37AM	10:26AM	0.55	2 18' REFRI
5	9	7603	254	229	7.03	5:40AM	12:42PM	1.40	1 12' REFRI
TOTALS	29	45996	1505	666	22.90			5.70	

THE POTENTIAL COMMISSARY FUNCTION FOR THE WHOLESALER

or

"How It All Might Work For The Independent"

by

Thomas F. Powers, Ph.D.

THE POTENTIAL COMMISSARY FUNCTION FOR THE WHOLESALER or "How It All Might Work For The Independent"

In the earlier sections of this report our contributors have spoken of the commissary as a part of a multi-operational chain under common ownership. The possibility exists, however, that the commissary role may be assumed by independents bent upon a new kind of wholesaler function.

Marketing in the food service industry has traditionally been almost synonomous with promotion. But in its fuller sense marketing encompasses not only the promotion of sales but also product determination and delineation of channels of distribution, both physically and institutionally. Thus classically, marketing begins with the design of a product for some consumer or group of consumers. The marketing process would then proceed to make or buy decisions on the basis of the most efficient and best qualified producer of the product. A way of relating the retail outlet to that manufacturer, either directly or through one or more intermediate selling agents like wholesalers or jobbers, would next be determined. Finally, the most efficient means of physically transporting the product to the retailer would be determined.

Because we in food service have been tied so long to a concept of production and distribution all under one roof, both physically and organizationally, considerations of how

we might take advantage of a more complex set of distribution channels might best be approached in the format of the following science fiction tale.

Let us suppose (as, indeed, has already happened in some places) that a large food service company with many operations in one city develops its own central commissary and finds that it has excess capacity. Either by approaching potential buyers or by having potential buyers sound out the producer, a limited number of products may be distributed to independent retailers (restauranteurs) in the commissary market area. Moreover, the commissary has a manufacturer-retail outlet relationship with the company's own units. This is a fairly straightforward situation.

What we need now is that imaginative and creative work of the American Enterprise System, a "new wrinkle" in the distribution system. Let us imagine a prosperous wholesaler with adequate access to capital who sees that custom preparation of food for some high volume outlets combined with the development of a standardized frozen-prepared line of foods under its own label for many smaller outlets is an economically viable idea. Such a production and distribution center might be acquired from an older existing food service company or might be jury-rigged and built as volume grew. The next stage might be reached when the volume of the jury-rigged wholesaler-commissary operation reached a size such that it became economically feasible to build a more efficient higher volume plant. The first paper in this volume gives us an idea of what such a plant <u>might</u> look like.

At the moment that this newer plant is built problems of maintaining sales volume--and perhaps some competition from other wholesalers seeing a profitable opportunity developed by the first company--might bring us yet another wrinkle in the highly flexible distribution system our economy provides us with. This "wrinkle" might be the emergence of a new kind of production manager-chef. Such a person would combine the foods know-how (a matter, really, of knowing flavor and quality in prepared foods) with a food science background. This combination would enable him, with the aid of a sales force, to approach quality operators in the city with a proposition like this:

"Let us take your specialty items and your recipes and redevelop them so that they can be frozen. We will do this work in our test kitchen under a contractual arrangement which protects, during development and at the end of development, your rights to the process. We can supply this service at cost or slightly above. When you are satisfied that we have redeveloped your product to your satisfaction so that it is truly and uniquely yours and yet can be produced and frozen in our plant and delivered to your door at convenient schedules, we will provide you with the recipe we have developed which will be legally yours. We will also make a bid on a year's (more or less) supply of the product we have developed for you. Because we are a local firm, our distribution costs will be minimal. Because we will be providing you with what is really the same food that you have

heretofore produced on your premises, you will not be compromising on quality for your guests and you can legitimately advertise the food as 'prepared by your own special recipe.'"

There are obvious advantages to this new commissary-wholesaler firm in undertaking this kind of work. First of all, a decent profit would be appropriately built into the pricing structure of the products developed and delivered. In addition to this, however, the wholesaler would have more outlets in which it might market some of its own standard, frozen-prepared products. And we could expect that it would have a distinct competitive advantage in supplying canned goods, cleaning supplies, paper products, and the whole range of food service products which presently move through the complex channels of distribution.

One further "wrinkle" is a distinct possibility: Instead of freezing, a local commissary-wholesaler might choose a produce and chill (instead of freeze) strategy for high volume customers based on daily delivery of the chilled product (and all other products purchased by those outlets). Work done by the Army suggests that there are some advantages in flavor for chilled products over frozen products and that, as long as the product is consumed within 72 hours, there is no perceptible difference in either flavor or microbiological exposure between the chilled product and the freshly prepared product.*

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*D. B. Rowley, J. M. Tuomy, and D. E. Wescott, Fort Lewis Experiment: Application of Food Technology and Engineering to Central Preparation. (Nadick, Massachusetts: United States Army Nadick Laboratories, February 1972).

It must be clear that this story is hardly a prediction of the precise way in which that most flexible of economic creatures, the channel of distribution, would render possible the development of individualized frozen (or chilled) foods for individual operators. It is simply our intent to suggest one possible scenario. It could happen that way or it could happen by some other combination of institutions. The important point to be made, however, is that the emergence of a number of small "food production shops" all competing with one another in the manner that small machine shops now relate to product manufacturers might lead to a competitive situation in which the price of frozen-prepared foods would be reduced both by competition and by the fact that the small producer would be a local producer with minimum transportation and distribution costs. The competition between producers, if it emerged, could lead to improved quality in the products purveyed. Finally, if reduced price, greater variety, and improved quality all became available, the ultimate beneficiary of these developments would be the consumer who would find it possible to buy a variety of excellent dishes in a restaurant at a reasonable price.

Since the restaurant industry is and will doubtlessly remain highly competitive, the reduction in the cost of the pre-prepared food might ultimately be passed on to the consumer in the form of lower prices. But one suspects that some of it would be absorbed in a shift in payroll from

back-of-the-house cooks to front-of-the-house servers. As noted elsewhere (particularly in Volume I) the key means of differentiating between restaurants that do not, for the most part, produce their own food would be location, atmosphere, and service. If the consumer got all the atmosphere now available in "experience restaurants," really fine food, and the improved service made possible by higher income for servers without any increase over present relative price levels, it seems that he would indeed have a bargain. But in the process, the face of the industry would be radically altered.

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